EDITORIAL

RAILROADS operating 41,988 miles of line in the United States, and having a capitalization of over two billion dollars are now in the hands of receivers. This is said to be a larger number than ever before in the history of the country.

OIL production figures for California show an excess of shipments over production of approximately 15,000 bbl. per day. Optimists should however remember that shipments frequently represent a replenishing of stocks rather than actual consumption, and furthermore, that it is estimated that there is a potential production of 18,000 bbl. per day from 'shut-in' wells.

PRELIMINARY work for the development of the San Francisco water-supply is being continued in the Hetch-Hetchy valley. The first large contract will be considered on November 24, when bids are to be received for the construction of the proposed railroad from Rosasco, on the Sierra railroad, to the floor of the Valley. Meanwhile the question of effecting the sale of the Hetch-Hetchy bonds at the low rate of interest prescribed, is still engaging the attention of the Board of Supervisors.

STRUCTURES that are strong enough to stand the heaviest service are usually easy to design. It is simply a matter of putting in enough material. On the other hand, it sometimes happens that greater skill is called for in the design of articles that have to withstand a comparatively slight strain, but which also must not cause too great a strain upon the purchaser's pocketbook. Catch-basin covers and appurtenances are usually required to develop great strength, but there are many situations where traffic is light, or where the grade is so steep that pedestrians only may be expected, so that lighter construction would be justified. The officials of a suburban town in California have recently found that the standard catch-basin appurtenances are heavier and more expensive that is justified by the conditions in a large part of the town. This would seem to be an excellent opportunity for an enterprising manufacturer.

COST of street-paving by day-labor on a job recently completed at Aberdeen, Washington, was apparently lower than the price for which the work could be done by contract. The lowest bid was $1.85 per square yard for asphalt pavement or a total of $17,378. The city officials decided to do the work by day-labor and the final cost is given as $1.40 per square yard. An overhead and superintendence charge of 30%, which is by no means unusual even on well-managed work, would have made the two prices practically equal. Without detailed figures, it is, of course, impossible to tell whether or not the City's costs include several items for which contractors must allow. It is significant, however, that the statement is made that the City put in use a concrete-mixer that had been lying idle for about two years. Interest and depreciation on this machine alone would have amounted to a considerable amount, and it is hardly likely that allowance was made for such items.

CONCRETE structures exposed to the action of sea-water have usually given complete satisfaction, but there have been some cases where the cement used has disintegrated causing failure. This has given rise to the belief that the use of concrete under sea-water is attended with many difficulties, and to a prejudice in favor of using other structural materials in such situations. On the other hand, we have great organizations like the Southern Pacific Company using concrete under sea-water continually and without experiencing trouble. In another column, we publish a summary of present practice in this regard prepared by Mr. William Hood, chief engineer for the railroad mentioned. It would seem that there are both chemical and mechanical requirements to be considered in order to obtain good results. The subject is of great interest to most engineers, and our columns are open for an exchange of experiences by members of the profession.

Commercializing Technical Societies

In January of this year at a joint meeting of the American Institute of Electrical Engineers and the National Electric Light Association, the consulting engineer of the Pacific Gas & Electric Company, Mr. Frank G. Baum, presented a paper entitled 'The Best Control of Public Utilities.' The paper gave unmistakable evidence of hurried preparation. At that time an important decision involving the rates of the company above-mentioned was about to be handed down by the Railroad Commission. In July the same subject was discussed by the same author in a more elaborate form under the title of 'Class Rates for Electric Light & Power Systems of Territories,' and presented at the annual meeting of the American Institute of Electrical Engineers. Again, at the Pacific Coast convention of the Institute in September there was a symposium on 'Inventories and Appraisals of Properties.' Two of the three papers were presented by Messrs. William G. Vincent and Clarence L. Cory, the former an employee in the Commercial Department of the Pacific Gas & Electric Co. and the latter a well-known consulting engineer who has been frequently employed in special work by that company. To this meeting the commis-

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sioners, rate experts, and engineers of the Railroad Commission of the State of California were specially invited. One of the speakers at the recent International Engineering Congress said that engineering, except as to details, was more a matter of finance than engineering. With this opinion most engineers of mature experience will agree. It will be recognized by such that the economics constitute a large part of successful engineering. They will agree, also, that the economics of a problem include the cost of production, and even of the sales of the product; and they will agree further that papers upon such subjects are very properly to be considered by the national technical societies, provided no attempt is made to promote either private or corporate interests thereby.

The right of public utilities to present arguments with a view to influencing the authorities—railroad commissions, for example—is equally undeniable, provided only that good taste and the proprieties are not overlooked. One might go even further and admit the right of any public utility corporation to show a considerable lack of good taste, and even to give evidence of a disregard for such proprieties, provided no one but itself became involved. If, however, engineers known to be on the staffs of important public corporations should present before national engineering societies papers dealing with rates and appraisals in such a manner, perhaps inadvertently, as to attract the attention of railroad commissions to these papers to a degree that might be construed as referring to matters then pending, those who hold old-fashioned views as to the code of conduct that should control the proceedings of such technical bodies, may be permitted to call attention to the grave misunderstandings that would ensue, particularly if the incident should prove to be one of a series and likely to establish a precedent. By all means let us have all the light possible on such subjects, and let every man have a full and free opportunity to express his views as frankly as may be, for out of the abundance of such discussion the truth is bound to come; but let us not lose sight of the fact that the commercializing of national technical societies, or even the appearance of it, cannot be approved, and we trust, will not be tolerated.

The Use of Concrete in Sea-Water

By William Hood

Present practice on the Southern Pacific railroad in depositing concrete under sea-water is about as follows. After selecting the best available cement, it is mixed rather dry and the concrete is deposited as much as possible where there is no current or movement of the water. A long cylindrical bucket with a butterfly-leaf bottom is used to deposit the concrete. This bucket is lowered into position closed and is hoisted away from the concrete so that the latter does not fall or drop through the water.

Cement that contains a large proportion of aluminum does not behave well under sea-water, but this tendency seems to be largely counteracted when a considerable amount of iron oxide is present. As a general rule, if the proportion of iron oxide is subtracted from the proportion of aluminum, the difference should not materially exceed 4%. For instance, if the proportion of aluminum is 7.11%, and the proportion of iron oxide, 3.34%, and the cement is otherwise satisfactory, it may be used under sea-water. Or if the proportion of aluminum is 6.71% and that of iron oxide, 2.09%, and the cement is otherwise of particularly good quality, it can still be used under sea-water.

It is also advisable to keep a careful watch upon the cement during the first few days after being mixed, and if it develops extreme slowness of setting or other objectionable qualities, to discontinue the use of that particular brand.

The Transcontinental Wireless Telephone

By A. H. Babcock

A real step ahead in the art of telephony was made on the morning of September 29, 1915, when officials from the American Telephone & Telegraph Company, the Pacific States Telephone & Telegraph Company, and officers of the Navy met at the radio station at Mare Island Navy Yard, for the purpose of a radio-telephone demonstration with Arlington, Virginia, and New York. The tower at Arlington was connected with the radio-transmitting apparatus, the tower at Mare Island with the radio-receiving apparatus. The transcontinental wire-telephone line was extended from San Francisco to Mare Island by a specially constructed loop, which also was 'morsed' for the purpose of telegraphic communication with Arlington. The first signals were received shortly after 4:30 a.m. and from that time until 10 o'clock, when the radio-telegraphic interference became serious, the spoken words were received through the ether almost continuously, the interruptions being for the necessary use of the tower for Navy Department purposes. Conversations were carried on between Mare Island and Arlington, also between Mare Island and New York, by means of the wire-line transmitting from Mare Island with the receivers connected to the aerial. At Arlington the connections were reversed—the transmitter being connected to the aerial and the receiver to the wire-line. When New York was connected, the transmitters at that point were connected with automatic repeaters to the aerial at Arlington, while their receivers were connected to the wire line. Newspaper reports indicate that Honolulu received the messages by radio from Arlington, and also from New York. Since the ether disturbances originating at Arlington were propagated radially, it is likely that many stations other than those reported 'listened in.' At the conclusion of the demonstration those at the table were presented by Mr. Carty with the receivers they used (later to have attached to them a suitably inscribed silver plate), and a photograph was taken of the entire group, including the Naval officers and electricians who were present. The effect of the radio-telegraphic interference in breaking up telephonic demonstrations indicated to all present the unmistakable necessity for Government control of the ether.

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REVIEW OF THE MONTH

OCTOBER was not so primarily a month of engineering conventions in San Francisco as September, still there were several of considerable interest to technical men. Prominent among them was American Builders' Week, which was celebtrated from October 18 to 23. That the visiting delegates were badged, dined, and otherwise entertained in the style that has become characteristic of a San Francisco convention, goes without saying. Perhaps this had something to do with the desire expressed by many of the delegates to hold a similar builders' convention every year. But an inspection of the program, which was given almost as it was originally printed, will show that the papers were worth going many miles to hear. A significant feature of the convention was the cordial co-operation between builder and architect, and the recognition that such co-operation is a necessity in every-day life if the best results are to be attained. In this as in many other conventions, probably the really important result was the getting acquainted. After all, the proper study of mankind is man.

ANOTHER convention particularly important to Pacific Coast engineers, was that of the American Petroleum Society. While many problems of the petroleum industry are being studied by other technical societies, the need has been felt for a general organization that would study the industry from all sides. Since its organization in 1913, the Society has been able to perform many services to the industry as a whole. Several important papers were presented before the convention, which was held in San Francisco from October 25 to 30 and much helpful discussion resulted. One result of the convention was the proposal to form a Pacific Coast section of the Society, with headquarters either in San Francisco or in Los Angeles, or possibly holding alternate meetings in each city. The oil industry is the second most important in the State and a branch of the Society should be of great service. Great credit should be given to Mr. Irving Allen, of the United States Bureau of Mines, to whose efforts the success of the convention is due.

SEEPAGE from canals was considered of small importance in the early days of irrigation on the Pacific Coast. Losses of 50 and even 75% between the intake and the farmer's head-gate were not at all unusual. Nowadays, however, not only is water becoming too valuable to be wasted in such a manner, but the flooding of adjacent low land must also be prevented. An irrigation company in Butte county, California, is preparing to oil its ditches to obviate these two evils. Local conditions in that neighborhood may be such that the use of oil is a wise move, but in other districts it has been found to be a waste of money. The oil-lining is not permanent, and it is also difficult to prevent oil being carried away as an emulsion in a sufficient amount to do some damage to crops. It is usually best to use a really permanent lining for irrigation-canals as soon as the finances of the district will permit.

DISLIKE of frequent elections and of radical changes in the law was shown by the voters of California on October 26. The election was characterized by a light vote and the defeat of nearly every constitutional amendment submitted. Some of the more important measures to suffer defeat were the establishment of a rural credit system, which it was believed would help to finance the new farmer, and thus indirectly aid irrigation and other colonization projects, and the extension of the condemnation privilege, by which a municipality would have been empowered to condemn land for future public use that was not actually needed at the time of acquisition.

A SIMILAR spirit of conservatism was shown in Los Angeles county, where a bond issue of $2,850,000 for extensions to the county highway system was defeated. Not only was there considerable reluctance to increase the county's obligations, but there was also some doubt as to whether the proponents of the measure had made a thorough study of the specific problem involved.

FAIR-PLAY to a public-service corporation was recently shown by the citizens of Bend, Oregon. An established light and power company had been rendering satisfactory service for a number of years when a competing company applied for a franchise with many promises of reduced rates, etc. This franchise was granted by the city council over the mayor's veto, and had the affair occurred a few years ago, when corporation-baiting was a national sport, it is probable that the affair would have ended there. However, the referendum was invoked, and after a hotly-contested election, the action of the council was reversed, and the old company is left in peace.

CENTRAL Oregon has long been recognized as one of the largest undeveloped regions in the United States. Transcontinental railroads surround it on all sides, but only a few branch lines even start to penetrate this region, and these do not extend far. Some of them do not pay well. A few years ago, the Hill and Harriman systems raced to build lines from the Columbia river up the Deschutes river to Bend, only to find on arrival that there was not enough traffic to pay expenses, let alone interest on the investment. Recently a committee of Portland citizens has engaged Mr. Robert E. Strahorn,

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a veteran railroad builder of the Northwest, to investigate the question of railroad facilities for this important region. His preliminary report has recently been made public. It recommends the construction of a line from Bend to Klamath Falls, with a branch connecting with Nevada, California & Oregon railroad at Lakeview, and another branch connecting with the Oregon Short Line in Harney valley. The mileage to be constructed is estimated at 400, and the cost on account of the generally easy country is placed as low as $6,000,000. As it is recognized that conditions are not such as to invite this investment on the part of any of the existing railroads, it is proposed to finance a new company by popular subscription. The development of the region in question would mean much to the Pacific Coast in general and we wish better success to the proposed company than sometimes happens to companies financed in this way.

ALTHOUGH this country is neutral in the European struggle, Americans directly or indirectly have rendered and are rendering valuable assistance to both of the warring factions. There may be room for an honest difference of opinion regarding the propriety of some of the aid that is now being received from this country. All but the most rabid partisans, however, can take pride in the fact that American engineers and American machinery have been largely instrumental in the successful completion of the new double-track railroad from Petrograd to Ekaterina on the Artic Ocean. While Archangel on the White sea is ice-bound for the greater part of the year, Ekaterina, which is some distance farther north is warmed sufficiently by the Gulf stream so that it is an open port throughout the year. The road was built for a distance of 600 miles across an almost uninhabited wilderness in less than six months.

OPERATORS on unpatented oil-land in California are facing serious trouble. New suits are being filed every few days and it seems probable that it is the intention of the Government to contest the title to all withdrawn unpatented land upon which operations are being or have been conducted. While the Southern and Coast fields, as well as those of Coalinga and Kern River, are but slightly affected, the situation in the Midway and Sunset fields is dismal. Several attempts have been made to influence Congress to pass remedial legislation for the benefit of operators who have spent large sums to develop oil, and who now are facing ruin in consequence of the attitude of the Federal government. Several causes, independent of the justice of their case have prevented success, thus far. Probably the most important has been the blind opposition on the part of most oil-men to any form of leasing system and their demand for a return to the old method of acquiring title to oil-land long after it became evident that such a thing was out of the question. This has led to the belief on the part of the layman, and most Congressmen are laymen when it comes to the oil business, that any legislation for the relief of operators would be against the spirit of real conservation. Added to this was the fact that many of the delegations of oil-men were themselves not agreed on what they wanted. With past failures in mind, a number of oil-men met in San Francisco on October 25 and organized the Oil Industry Association, electing Mr. R. N. Bishop, president, and Mr. Herbert Fleishacker, treasurer. While the awkward position of the companies on unpatented land is the immediate reason for the formation of this association, the members have wisely decided to forestall opposition from certain quarters by stating their purpose to be the general betterment of the industry. That the industry is in need of betterment none will gainsay, so the new association should have a large membership.

STANDING in the lobby of the Palace hotel, the owner of a well-known oil-producing lease in the Midway field recently remarked to a group of friends: "My property never made any money until I stopped drilling. This agreement to suspend drilling operations was a good thing for me. I have 15 wells now and room for 30 more, but I hope I shall never have to drill them. I can't pay dividends while I keep drilling—the profit goes right back into the ground." But is he making money now? Or is he simply postponing the fatal day? When his present wells, through their inevitable decline in yield, cease to be profitable, where will he find the money to drill the next 10 or 15 wells required to continue his present output? Obviously, from his present 'profits,' which he is, sad to say, putting in his pocket only temporarily.

IN this issue we publish a study, by Mr. M. E. Lombardi, of one of the elements of the many that go to make up the true cost of producing oil in California. The expense of maintaining production is easily overlooked by the investor in oil shares or properties, but it remains a basic fact. There is the inevitable decline in production from old wells, once a satisfactory dividend-paying output has been reached; this must be met by drilling—and yet more drilling—as long as there is land to drill. The present persistently low price for crude oil has given pause to the operator in his mad rush to lease and drill. In the interim between booms he has had time to look around and take stock, to calculate carefully how much of his past or of his hoped-for future dividends are really 'profit.' He has not had as a guide the experience of a long past like the California metal-miner. Nor has he at his disposal the technical skill, brains, and experience of the tribe of metal-mining engineers. He is having his first lesson in ultimate ratios dominating his business. It may be that dull times have their use in teaching him the realities of the oil industry. Meanwhile in his moments of leisure he cannot do better than read the article on 'The Cost of Maintaining Production in California Oilfields.' If he will "read, mark, learn, and inwardly digest" that thoughtful exposition of the subject, he will be a wiser, and possibly a sadder, man; but the sadness will prove evanescent while the wisdom may remain a useful asset to him in his further activities.

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The Waterway at the Mare Island Navy Yard

By M. H. PECK*

When the United States Navy Yard was established at Mare island, California, the situation was ideal for the conditions of the time. The position was protected in a military sense and against storms; there was water of sufficient depth for the deepest-draught ships; there was a railroad on the mainland, on the other side of Mare Island strait; the water was sufficiently brackish to cleanse the bottoms of ships from marine growths and to kill teredo and other marine borers; there was abundant anchorage-room with good holding-ground north of the situation selected for the Yard, and plenty of level ground for the shops and docks required; and the town of Vallejo, on the other side of Mare Island strait, provided accommodation for the civilian employees of the yard, and a labor-market as good as any on San Francisco bay. These advantages still exist, except that the increase of draught of ships demands a deeper channel than was needed fifty years ago, while the channel shoaled steadily from 1856 to 1905, and was never deep enough for a modern battleship until after the last dredging in 1913-1915. At one time the approach channel became so shallow that the navy yard was reduced to a second-class yard. The other advantages of the situation, however, were so great, the Government's investment so large, the Yard equipment so good, and the work done there so satisfactory, that a study of methods to remedy the defect in the channel was made in 1902 and much improvement subsequently obtained.

The purpose of this article is to describe the situation, character, obstructions, and improvements of the channel to the Mare Island Navy Yard, and to forecast the degree of its continued usefulness.

Situation. The Mare Island Navy Yard is about twenty-five miles from the Golden Gate, and lies on an island bordering San Pablo bay on the east, and separated from the mainland of Solano county by Mare Island strait, which opens into Carquinez strait at its junction with San Pablo bay. Approaching the Navy Yard from the Ocean, the first obstruction to the free passage of ships is the bar outside the Golden Gate. The depth at low water in the South channel is 38 ft., in the Middle channel 33 ft., in the North, or Bonita, channel, 45 ft. The North channel is somewhat dangerous on account of the rocks lying in it, but the worst of these is now being removed. After entering San Francisco bay, the next obstruction is Pinole shoal, in San Pablo bay, about five miles long in the direction of the deep-water channel, which was about 21 ft. deep before dredging. The War Department has dredged a channel 30 ft. deep at low water through this shoal and has built a hopper suction-dredge to maintain this depth for commercial navigation. The next obstruction is the bar at the entrance to Mare Island strait, and the last are the shoals and Commission Rock in the strait itself. The bar and obstructions within the strait form the problem to be dealt with by the Navy Department, as the War Department will maintain a 30-ft. channel through San Pablo bay. If the Navy Department is able to maintain a channel 30 ft. deep at low water from Carquinez strait to the Navy Yard, the Yard will be accessible to ships drawing up to 34 ft. in calm weather, or 32 ft. in rough weather, as the average range of tide is about six feet.

Character. Mare Island strait is a tidal channel receiving the upland water of the Napa river. The amount of this upland water is negligible as compared to the tidal flow. The average range of tide is about six feet, the extreme range ten feet, and the range of ordinary spring tides eight feet. The time of low-water at the south end of the island is 2 hr. 5 min. behind the time of low water at Fort Point on the Golden Gate, and the height the same. The time of high water is 1 hr. 45 min. behind Fort Point, and the height 0.9 ft. greater. As at other points on the Pacific Coast, the greatest range of any given day is during one of the ebb tides. The low-water area of tidal waters above the south end of Mare island, including only the main channels and not the salt-water marsh, as taken by planimeter from the Coast and Geodetic Survey map, is about 8.6 square miles. The area measured does not extend above the town of Napa, although the effect of the tide goes somewhat farther, and there are numerous sloughs not included.

Obstructions. The obstructions in Mare Island strait consisted of a bar at the entrance, a peak called Commission Rock lying at about the centre of the Strait, and the shoal-water of the strait itself. The bar has been formed since 1851, and consists of fine sand, mixed with silt. Commission Rock rose to within two feet of mean low-water. Though its removal had often been proposed, no careful examination of the character of the rock was ever made until bids were asked for its removal in 1913. Borings made at that time, and observations made during the removal of the rock, show that it consisted of two irregular masses of clay, sand, and mixtures of clay and sand, capped and intersected by thin strata of sandstone, and underlaid by ledges of metamorphic sandstone and other hard rock, with a separate peak of green sandstone, grading from soft and friable at the top to very hard at a depth of

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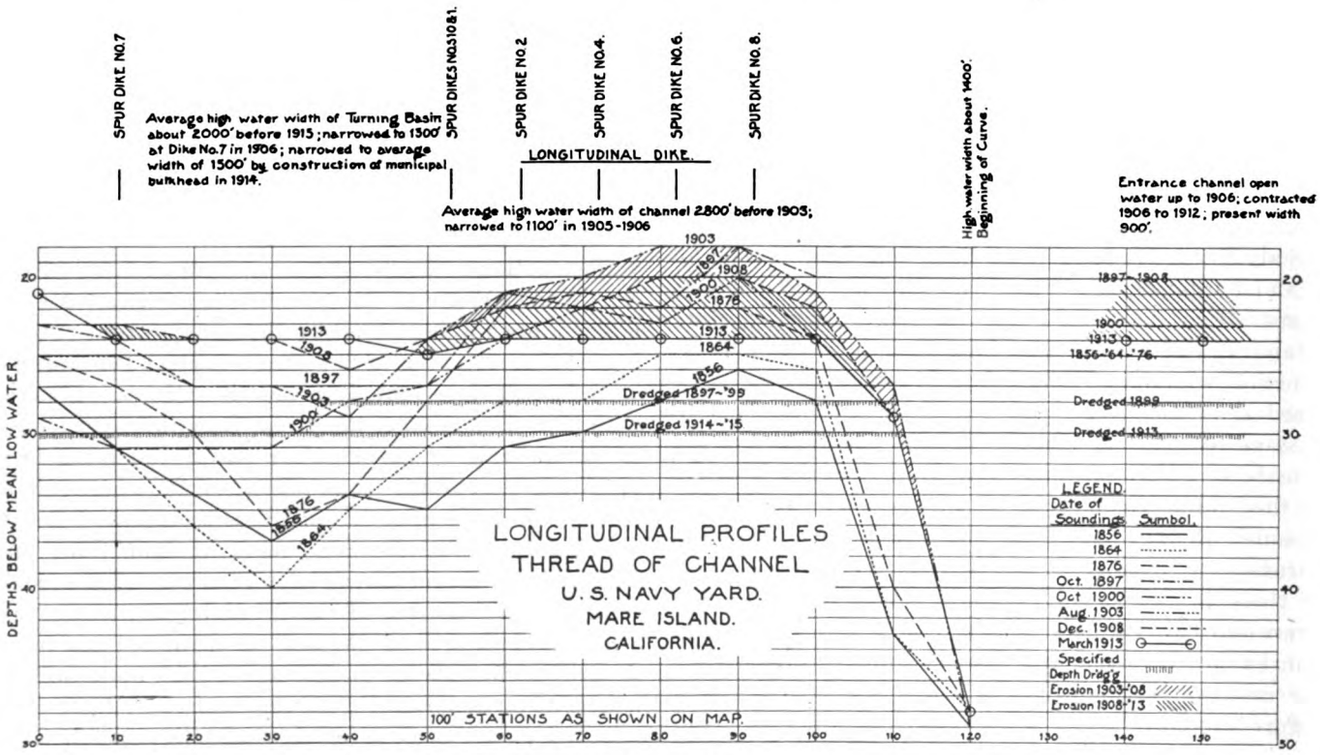
30 ft. below low water. The bottom of the strait consisted of fine sand mixed with an almost impalpable silt or slickens, with underlying firm clay, shell, and gravel, in irregular deposits.

The progressive silting of the channel since 1856 is shown by the profiles. A study of these profiles shows practically continuous silting in all parts of the channel between 1856 and 1903. The channel was dredged as shown on the profiles in the period of 1897-1900, but immediately silted up. The only other dredging, except by a small clam-shell dredge operated by the Navy Yard, was in the period of 1913-1915. The controlling depth of the channel and bar, as shown by charts at the Navy Yard, and on the profiles along the thread of the channel, was 26 ft. in 1856, 25 ft. in 1864, 21 ft. in 1876, 18 ft. in 1897, 20 ft. in 1900, although the channel had been dredged to a least depth of 28 ft. between those years, 18 ft. in 1903, 20 ft. in 1908, the system of regulating dikes having been constructed between the last two dates, and 24 ft. in 1913.

Improvements. The first effort to increase the depth of water in the channel, aside from the removal of silt along the quay-wall and at the mouth of the drydock, was the dredging done in 1897-1900. A contract was let to the San Francisco Bridge Co. for dredging a channel along the quay-wall, 100 ft. wide by 30 ft. deep at low-water, and a channel from the Navy Yard to natural deep-water between the magazine reservation and the Sperry mills, from 250 to 400 ft. wide and 28 ft. deep. A channel was also dredged across the bar, 600 ft. wide by 28 ft. deep. This dredging was supplemented by a contract with the Atlantic, Gulf & Pacific Co., in 1899, for a turning-basin opposite the Navy Yard, 900 ft. wide by 28 ft. deep, and the widening of the 28-ft. channel already dredged to 400 ft. at all points. As is shown by the profiles, the channel immediately silted up, indicating that dredging alone would not produce a stable deep-water channel. Accordingly an investigation of the cause of the silting of the channel was commenced in 1902.

Float-observations were made of tidal currents at all stages of the tide to determine their velocity and direction. Samples were also taken at different positions and depths, to determine the amount of solids carried in suspension by the various currents. About six subsurface floats carrying different-colored flags, distributed across a cross-section of the channel, were released at the same time. The length of the channel was divided into sections and three or four transits set on shore, so that at least two transits could observe a float at any point in each section. Angles were read at predetermined times on each float, and the successive positions of each float plotted on a large-scale map. The position, direction, and velocity of the current at the time of observation were determined from the map. The most important discoveries were that flood-tide currents carried more silt than the ebb, and that the current carrying most silt came around the south end of the island from San Pablo bay. The following facts explain the latter condition. The reports of the United States Weather Bureau for 41 years show that in the normal year the prevailing winds of San Francisco are from the west and southwest for ten months of the twelve. San Pablo bay is 11 miles from west to east, and about the same from southwest to northeast; the natural deep-water channel runs from the passage be-



PROFILES OF CHANNEL.

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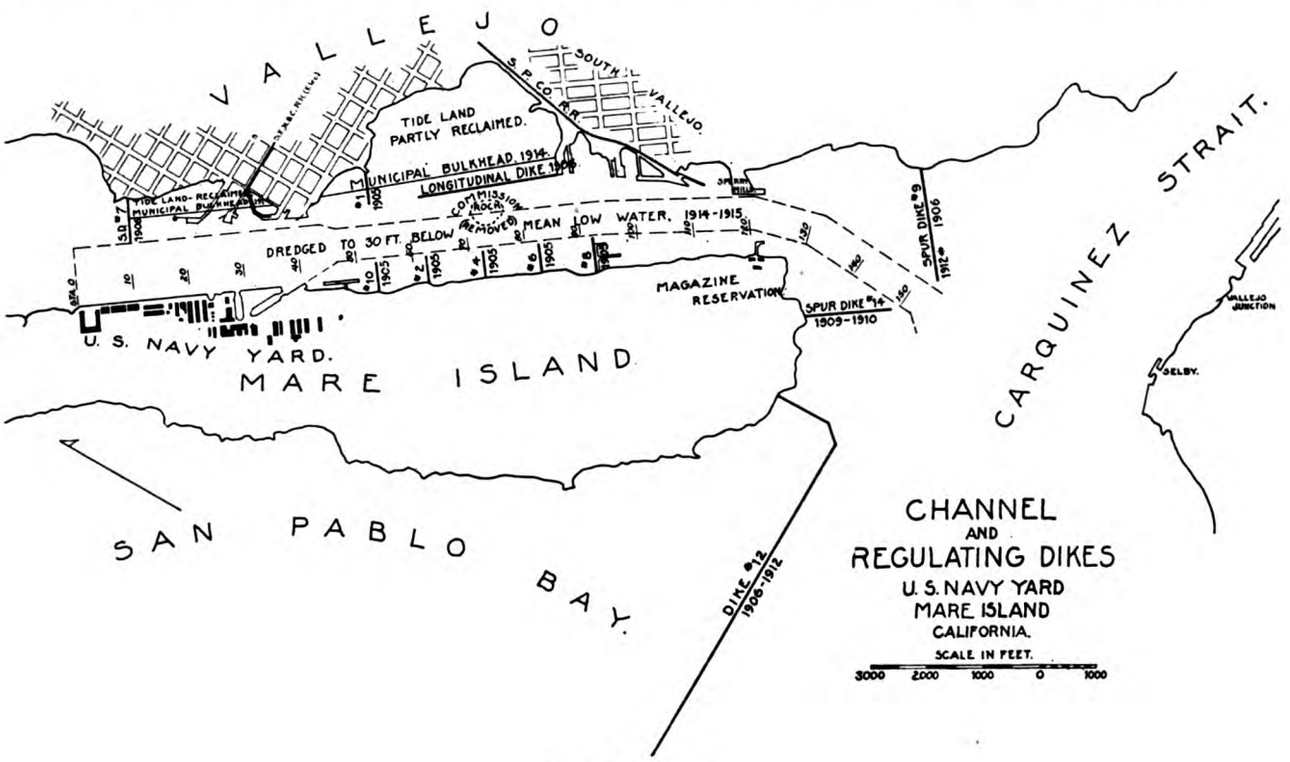
tween McNear's point and Point San Pablo in a northeasterly direction to Carquinez strait. North and west of this channel the average depth is about three feet. The prevailing winds cause wave action, which stirs up the mud, and wind-currents, which carry this mud into the sweep of the flood-tide currents in the deep-water channel. A study of the results of this investigation led to the designing of a system of regulating dikes, the construction of which was recommended by the civil engineer stationed at the Navy Yard. The construction of this dike system was commenced in 1904, and the main units, for the distances tentatively established, were completed in 1906. Some units were lengthened in 1909 to 1912, and an additional unit (dike No. 14 at the south end of the island) was built in 1909-1910. As is shown on the map, the system consists of three parts: first, a dike (No. 12) extending in a southwesterly direction from the south end of Mare island into San Pablo bay, to divert the silt-bearing flood-tide current into deeper water in San Pablo bay, and so reduce the amount of silt carried by it. Second are two spur-dikes (No. 9 and 14) to confine and direct the ebb-tide currents across the bar at the entrance to Mare Island strait. Third, a series of spur-dikes and one longitudinal dike to narrow the channel in Mare Island strait, and thus increase the velocity of the ebb-tide currents. One of these spur-dikes, on the east side of the strait about a mile north of Vallejo, is not shown on the larger-scale map. All dikes are of pile-construction, the standard design consisting of a row of 12 by 12-in. sheet-piles, held by two wales on each side, each set of wales supported by round standard piles about 10 ft. centre to centre, and each standard pile braced by one or two piles at a slope of about 3 on 2. The inshore ends of spur-dikes are of lighter construction, and the longitudinal dike is tied back to a system of brace-piles on the land side. This dike system, as is shown by the longitudinal profiles, caused a deepening in the contracted channel of 2 ft. before 1908, and of from 2 to 4 ft. between December 1908 and March 1913.

By 1908 it was recognized that the Pinole Shoal channel would not be self-maintaining at a depth of 30 ft. By authority of Congress the President appointed a board consisting of two engineers from the Army, and one civil engineer from the Navy, with another engineer from the Corps of Civil Engineers of the Navy as recorded, to investigate the water approaches to the Navy Yard and to recommend improvements. After some months of study this Board recommended some extensions of the dike system, dredging the channel to a depth of 30 ft., and the removal of the part of Commission Rock outside the channel to a depth of 20 ft. It also recommended that provision be made for further dredging of Pinole shoal and Mare Island strait as would be required, preferably by a dredge owned and operated by the Government. The dredging of the channel was recommended by the Board because it was concluded that the dike system would not cause erosion sufficient to obtain the required depth; the accuracy of this conclusion was confirmed by an investigation of the channel that I made in 1913 on behalf of a bidder on the dredging contract. The bottom of the turning-basin (Stations 0 to 40 on the map) was so soft that it was impossible to establish exactly the boundary between water and mud, showing that the



MAP OF CHANNEL.

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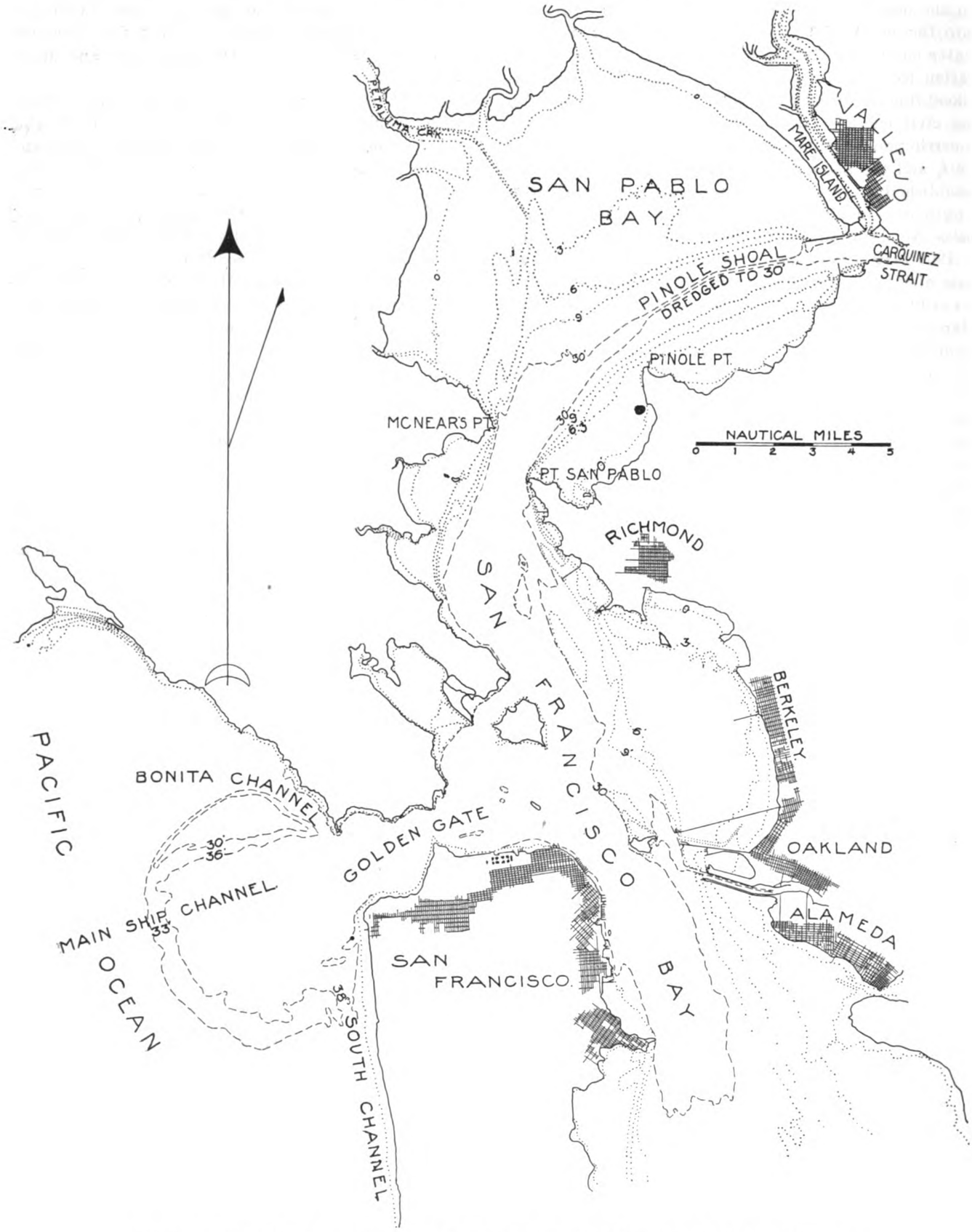
ebb-tide did not remove all of the silt deposited at high-water, while in the approach channel to the Navy Yard (Stations 50 to 150 on the map) the bottom was hard under the lead, showing that any considerable further deepening by erosion was improbable.

Acting on the recommendation of the Board, Con-



MAP OF SAN FRANCISCO BAY AND VICINITY, SHOWING RELATIVE POSI TION OF MARE ISLAND NAVY YARD.

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gress appropriated funds for extending the dike system, as shown on the larger scale map, and for the dredging recommended. In 1913 a contract was entered into between the Navy Department and R. A. Perry for dredging the channel and turning-basin as shown on the map, and removing the part of Commission Rock outside the channel to a depth of 20 ft. The approach channel was to be 600 ft. wide by 30 ft. deep, and the turning-basin 1000 ft. wide by 30 ft. deep. The execution of this contract was commenced in October 1913 and completed in May 1915. I was in charge for the contractor. Soundings taken since completion of the dredging show no silting likely to threaten the usefulness of the approach channel. On the convex side of the curve in the entrance channel, between Stations 130 and 140 on the map, the silting amounts to 7 or 8 ft., while at a point 150 ft. from the side of the channel it is only 3 ft., and less than 1 ft. at the centre, with a 2-ft. vertical scour on the concave side. As this part of the channel was dredged in November 1913, the silting was done in 18 months. A navigable channel across the bar apparently will be self-maintaining, but a parallel dike on the concave side may be required to keep the curve on a convenient radius. A strip 150 ft. wide along the western or Mare Island side of the channel, between Stations 70 and 90, silted from a few tenths of a foot to three feet at the side, in 14 months; the remaining width of 450 ft. showing no silting. The soundings show a silting of one to two feet across the channel between Stations 50 and 70, in about 13 months, but this was evidently due to the fact that Commission Rock, which was not removed until the completion of the rest of the dredging, formed a barrier which prevented the removal by the ebb-tide of silt stirred up by dredging operations in the channel and turning-basin north of the Rock. This is indicated by the fact that more than a year after it was dredged the bottom of the channel south of the Rock was hard under the lead, showing that no silt whatever had remained there. A part of the silt north of the Rock was removed by the dredging contractor, and for reasons which will be stated later, I confidently expect that within a year's time the natural scour will produce a depth of not less than 30 ft. at low-water in the short stretch of approach channel now only 29 ft. deep.

Maintenance. As may be seen on the map, the channel is divided into two sections, the wider northerly section constituting the turning-basin, and the remaining section, 600 ft. wide, forming the approach channel. Conditions affecting the maintenance of the desired depth differ in the two sections. It has just been stated that the approach channel probably will be self-maintaining; the turning-basin will now be considered.

Soundings taken in May 1915 show silting in the turning-basin at rates varying from one to five feet of depth per year, with an extreme rate of six feet per year in the northeast corner of the basin. The intervals between successive soundings varied from five to eleven months. The rates of silting at different distances from the quay wall show that the thread of the channel runs about north and south, north of the Navy Yard, swinging to a position east of the centre-line of the turning-basin near Station 30, and then approximately paralleling this centre line to where the turning-basin joins the approach channel. The silting was least on the west, or Mare Island, side of the turning-basin opposite Dike No. 7, and is about the same on the two sides of the turning-basin at Station 40. The average rates of silting per year in cross-sections 1000 ft. apart, covering periods of five to eleven months after dredging, are as follows: Station 0, 4.7 ft.; Station 10, 2.6 ft.; Station 20, 3.4 ft.; Station 30, 4.0 ft.; Station 40, 3.6 ft. The low rate at Station 10 shows the effect of the decreasing of the cross-section by Dike No. 7, and the higher rate at Station 30 shows the effect of comparatively deep water on the Vallejo side, increasing the cross-section. Neglecting Station 0, which formed the limit of dredging in 1914-1915, the average rate of silting over the whole turning-basin, calculated from observations made from five to eleven months after dredging, was 3.4 ft. of depth per year.

The actual silting in one calendar year following dredging will probably be less than this, as soundings taken between October 1900 (after the turning-basin was dredged to a depth of 28 ft.), and March 1913 show silting at the rate of 2.2 ft. for the first year, 2.0 ft. per year for the second and third years, 0.15 ft. per year for the fourth to eighth years inclusive (Dike No. 7 being built during the sixth year, and one intermediate set of soundings being taken nine months after its construction), 0.61 ft. per year for the ninth to eleventh years inclusive, and a scour of 0.19 ft. per year for the twelfth and thirteenth years. These figures appear to be inconsistent, or at least to contradict any simple theory of the régime of a tidal channel, but a study of local conditions shows that they confirm the rational theory of silting in such channels.

In a purely tidal channel, the silt brought in by the flood-tide is more or less completely deposited at high-water, and more or less completely picked up and carried away by the ebb. Some deposit also is made undoubtedly at low-water. Therefore the resultant rate of silting for any given kind of silt depends mainly on the amount of silt brought in, and the velocity and duration of the ebb-tide current. The figures given above show the effect of the construction of Dike No. 7 (January 1906) in decreasing the silting by contracting the channel, and thereby increasing the velocity of the ebb-tide current, and also show the increase in silting from 1908 to 1911 (ninth to eleventh years after dredging) caused by the building up of the bottom of San Pablo bay north of Dike No. 12, and the consequent increase in the amount of silt carried by the flood-tide or wind-current passing around the south end of the island from San Pablo bay. In 1912 Dike No. 12 was extended and this current thrown into deeper water, thus decreasing the amount of silt picked up and brought in by it, until the scouring effect of the ebb-

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tide in the turning-basin more than balanced the silting at high-water. It may then be considered that under present conditions, that is, with the present horizontal dimensions of the turning-basin, and with the flood-tide current from San Pablo bay kept in water sufficiently deep to prevent the picking up of much silt, the average stable depth of the turning-basin will be somewhat greater than the average depth in 1913, which was 21.8 ft., and somewhat less than the average depth in 1906, which was 23.7 ft. We may also conclude that the rate of silting will not exceed 3 ft. of depth for the first year after dredging to a depth of 30 ft., and 2 ft. per year for the two succeeding years; thus requiring at least three years, and possibly longer, to bring the turning-basin to its stable depth of about 23 ft. In order to maintain a minimum depth of 25 ft. at low-water under present conditions it will then be necessary to remove a maximum of 800,000 cu. yd. of semi-liquid silt every two years. If this is done, under the worst conditions a ship drawing 30 ft. can be brought up to the turning-basin on a 2 ft. tide—the approach channel being adequate, as has been shown—taken into the turning-basin at high-water, and if kept there will rest in a bed of soft ooze at low water. If a minimum depth of 30 ft. is desired, the basin must be dredged to a depth of 35 ft.; and the amount to be removed biennially will be about the same. As the War Department is now building a hopper suction-dredge for use on Pinole shoal, the biennial dredging of 800,000 cu. yd. can be done at a low figure, whether by the Government dredge or by contract, and will be practically all the maintenance required to make the Navy Yard fully available for the repair of ships drawing up to 32 ft. It must be borne in mind that where hard bottom existed, the recent dredging has removed it to depths of from 31 ft. to 33 ft. below low water, and that the controlling depths mentioned above are to the surface of a soft, in fact semi-liquid, mud. The joint Board of Army and Navy engineers previously referred to estimated the probable cost of maintenance of a 30-ft. channel, including dikes and dredging, at $70,000 per year. The data given above show that $40,000 per year should be sufficient for the required dredging and the maintenace of existing dikes, but that an additional parallel dike on the east side of the entrance channel, between Dike No. 9 and the Sperry mills, may be required. This dike would be between 2000 ft. and 2500 ft. long, and would cost about $100,000.

A brief study of the available data on the tidal-flow and the known cross-sections of Mare Island strait may be of interest, though the data at hand at the time of writing is not sufficient basis for any definite conclusions.

Velocity. Current meter readings, taken at full ebb of a 6.3 ft. 'run-out,' show an average velocity in the cross-section between the Sperry mills and the Magazine wharf of 3.7 ft. per second. The period of ebb-tide flow with reference to the times of high and low-water, and the average velocity throughout the flow of ebb-tide, are not known.

Areas of Cross-Sections. Four sections are chosen at typical or critical points: all areas given are below approximate mid-tide level, which is taken as 3 ft. above mean lower low-water.

Station 120 (Sperry mills to Magazine wharf). Total area of cross-section, 39,300 sq. ft. below mid-tide level, and the hydraulic mean-depth about 28 ft. As shown on the map, this section is at the beginning of a curve.

Station 83 (Dike No. 6). Assuming a width of 100 ft. of the channel inshore from the end of the spur-dike to be effective, the area of cross-section in 1913, before the last dredging, was 28,300 sq. ft. After dredging a channel 600 ft. wide by 30 ft. deep, the total area of cross-section was 32,500 sq. ft. The hydraulic mean-depth of the improved channel is approximately 27 feet.

Station 45. In 1913, before dredging, the area was 30,100 sq. ft. After the channel was dredged the area was 34,800 sq. ft. and the hydraulic mean depth approximately 25 feet.

Station 10 (Dike No. 7). Before dredging, the area was 30,900 sq. ft. After the dredging of the turning-basin 1000 ft. wide on the bottom and 30 ft. deep, the area was 40,400 sq. ft., and the hydraulic mean depth 28 feet.

For the Brazos river in Texas, Ripley found the sectional area to be 13.5% greater, and the hydraulic mean depth 24.5% greater, at curves than in straight reaches. The stable area at Station 120, at the beginning of a curve, being 39,300 sq. ft., and the hydraulic mean depth approximately 28 ft., the stable area of cross-section in straight reaches of this channel should be about 34,600 sq. ft., and the hydraulic mean depth not less than 22.5 ft., if the same relations exist as for the Brazos river. The figures given above show that the straight reach from Station 50 to Station 120 satisfies both these conditions with a margin of safety, for the channel as dredged; that the improved channel at Station 40 may possibly be near the maximum stable section, and that the turning-basin probably will silt up to some extent. The cross-section of Station 120 is the maximum stable cross-section for the local condition and situation, for while the bottom is hard in the deeper part of the section, there has been silting in front of the Magazine wharf, on the convex side of the channel curve, and there is some soft material under the Sperry Mills wharf, where the current is somewhat checked by the piling. The average velocities in different cross-sections of a given constant current being inversely proportional to their areas, the average at full ebb at any point in the improved channel between Station 40 and Station 120 will be between 4.2 ft. and 4.5 ft., per second, and the bottom velocity about 2.5 ft. per second, while at the narrowest section of the improved turning-basin the average and bottom velocities will be about 3.7 ft. and 2.2 ft. per second respectively. In 1913, when this section of the turning-basin was slowly eroding, its area was 30,900 sq. ft., and the calculated average velocity 4.7 ft. per second. The slow rate of erosion

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shows that this must be near the critical velocity. An approximately equal area of cross-section, and similar conditions, existed near Station 45. The calculated velocity for the assumed stable section for straight reaches (34,600 sq. ft.) being 4.2 ft. per second, the Brazos river averages apparently may be applied to this channel under present conditions. It is interesting to note that Prof. Luigi Luiggi, in a paper on 'Works for the Improvement of Navigable Estuaries,' read at the International Engineering Congress this year, states that "the bottom current must reach at least 0.6 metre (2 ft.) per second in order to be able to exercise any erosive action and to prevent filling up the channel." Prof. Luiggi makes no mention of the influence in its resultant silting or erosion of the amount of silt carried into a tidal channel, and it may be that this neglected factor explains the difference between his minimum safe velocity of 2 ft. per second, and the 2.5 ft. per second that is apparently required in Mare Island strait.

The foregoing theoretical considerations, together with the investigation of the history of the channel as shown by the longitudinal profiles, led me to state before Assistant Secretary of the Navy Roosevelt at the time of his visit to the Mare Island Navy Yard in 1914, that it was my opinion that a 30-ft. channel from Carquinez strait to near Drydock No. 2 (about Station 38) would be self-maintaining, though probably not for the full width of 600 ft. The time elapsed since the dredging of the channel is too short for absolute proof of the correctness of this opinion, but the data given earlier in this article on the condition of the channel since the last dredging strengthen its probability. When records covering the régime of the dredged channel for two or three years are available it will be possible to calculate the maximum self-maintaining cross-section for different depths at any point in the channel, and possibly to deduce the minimum average velocity at full ebb which will prevent shoaling. This limiting velocity will be valuable in designing other channels under similar conditions of alignment of channel, periods of tidal flow, and silt-carrying currents, but would have to be used with great care, as it is difficult, if not impossible, to measure or describe with any accuracy the two latter conditions.

The Navy Department has two yards on the Pacific Coast, one at Bremerton, on Puget sound, and the other at Mare island. As there is obvious need for at least two navy yards, and the Navy Department has officially recognized this need, there is no necessity for comparison between the existing yards. The advantages of San Francisco bay as the location of one of these yards are too numerous and obvious to need mention, and one yard undoubtedly will always be on that bay. During the last few years a number of places on the bay have claimed advantages as navy-yard sites superior to those of Mare island; some of these claims are well founded and the advantages real, and some have obviously been based on the hopes of real-estate owners or speculators. Unfortunately some of the claimants have thought it necessary or advisable to disparage not only the depth of the water in the Mare Island strait, but also the motives of those who recommended its improvement. In the interests of fair play I have desired not only to describe briefly the hydraulics and improvements of the water approach to the Navy Yard as a matter of engineering interest, but also to show that the improvements have been successful, and that the Mare Island Navy Yard can be maintained as a first-class yard at reasonable cost. I have heard a high official of the Navy Department state that reports from the Mare Island Navy Yard showed such economy in the construction and repair of ships, as compared with other yards, both Government and private, that he made personal investigation of their reliability. He concluded that this economy was due partly to the quality of the personnel of the Yard force, naval and civilian, and partly to the climate, which permits practically continuous construction work under favorable conditions throughout the year. While climatic conditions do not vary greatly at different points on San Francisco bay, and the personnel could be transferred, the Government has an investment of between $10,000,000 and $15,000,000 (present inventory value) in land, shops, drydocks and other improvements, which would be worth but little if the Yard were moved. About $1,500,000 has been expended in dredging and regulating the channel. Of this, $500,000 was expended before 1904, and produced no permanent improvement; three-quarters of the remaining million has been expended for dikes and the maintenance of a clam-shell dredge for working along the quay-wall and at the entrances to the drydocks, and about a quarter of a million has been expended for the last dredging contract. As the result of this expenditure a channel 30 ft. deep at low water can now be maintained at a reasonable cost.

Briefly, the present situation of the Navy Yard at Mare island has the following advantages.

Protection from hostile navies or armies.

Protection from all storms.

Water sufficiently brackish to kill marine growths on ships' bottoms, as well as teredo and other marine wood-borers.

Accessibility to the largest ships now in the navy, or likely to be built.

Ample level ground adjacent to the water-front for additional shops and drydocks.

Railroad connection on the opposite side of Mare Island strait.

Established personnel of high quality.

Climate favorable to outdoor work at all seasons of the year.

There is no other situation on San Francisco bay with superior natural advantages except as regards deep water. With this problem solved, as I believe it has been, there is no better situation for a navy yard on the Bay than the present one.

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THE ARROWROCK DAM

By M. F. CUNNINGHAM*

The Arrowrock dam near Boise, Idaho, is completed and has been in service during the irrigation season of 1915. This dam provides stored water for use in the irrigation of lands adjacent to Boise, Nampa, Caldwell and other towns within the limits of the Boise project of the United States Reclamation Service. The dam is the highest in the world, having a height of 348.5 ft. from the lowest point in the foundation to the top of the parapet. It is 1100 ft. long on top and contains 585,200 cubic yards of concrete. The crest carries a roadway 16 ft. wide. The dam has a gravity section and is built on a curve of 660-ft. radius. The spillway consists of an opening 400 ft. long and a concrete-lined discharge-trench approximately 900 ft. long with a capacity of 40,000 cu. ft. per second. In the opening and the trench-lining there is in all 25,400 cubic yards of reinforced concrete.

The spillway opening carries a movable crest that permits the storage of water six feet higher than the fixed crest, but drops automatically, but slowly, in case of flood, so as to provide the full capacity of the spillway when needed. It rises again automatically when the flood has passed.

A log-conveyor with a capacity of 1,000,000 lin. ft. per day permits the passage of logs to the mills below. The logs are hoisted to the top of the dam by a cable-lift and taken to the river below the dam through a reinforced concrete chute 650 ft. long, the upper 400 ft. of which carries a bull-chain with spurs or teeth set to hold against sliding. This carries the logs down a 62½% grade and delivers them to a gravity chute through which they pass to the river. It is estimated that there is three billion feet of timber in the Boise basin above the dam that will be handled in this way.

Preliminary to the construction of the dam, it was necessary to construct a standard gauge railroad 17 miles long from Barber Junction on the Oregon Short Line to Arrowrock. This railroad has been in operation four years, and in that time it has carried 80,000 passengers. The freight business has amounted to 14,000,000 ton-miles. It is the only railroad in the United States proper that is operated by the Federal government.

A 3000-hp. hydro-electric power-plant was built to furnish power for the operation of the construction plant. This has furnished all the electric power needed for construction purposes, and in addition considerable of the surplus output has been sold to local companies. The total output since May, 1915, has been almost 20,000,000 kw. hours. A sawmill was operated for two years in the timber about 17 miles above Arrowrock. This furnished 6,750,000 ft. B.M. of lumber all of which was used for the building of the construction camp at Arrowrock, and to fill other miscellaneous requirements of the work.

The excavation for the dam extended 90 ft. below the river-bed to the granite bedrock. A diversion-tunnel 500 ft. long and 25 by 30 ft. in cross-section carried the river around the work until the construction was far enough advanced to start the storage of water.

There are 20 regulating outlets in the dam, each having a diameter of 4 ft. 4 in. They are controlled by a 58-in. balanced needle-valve on the upstream face of the dam, and are arranged in two sets of ten each, the upper set being 150 ft. above the river-bed. Five sluicing outlets, each controlled by a 5 by 5 ft. sliding gate, are also provided at river-level. All these outlets are operated from control-chambers inside the dam.

A system of inspection-galleries, of which the control-chambers are a part, gives access to the dams at several different elevations, the lowest of which is 230 ft. below normal high-water surface in the reservoir. The capacity of the reservoir is 244,300 acre-feet, or about 79,600,000,000 gallons. The reservoir is 18 miles long and extends up two forks of the river. When used for irrigation, the water is carried for 12 miles in the channel of the river to a low diversion-dam. From this point a network of canals and laterals extends over the land. About 234,000 acres of land, formerly sage-brush desert, is to be irrigated.

The principal quantities involved in the construction of Arrowrock dam and the spillway are as follows:

Excavation	683,000 cu. yd.
Concrete	610,600 " "
Reinforcing steel	1,350,000 lb.
Gates and structural steel	3,600,000 "

The work was under the general direction of F. E. Weymouth, supervising engineer of the United States Reclamation Service, with Charles H. Paul, construction engineer in direct charge, and James Munn, superintendent of construction. The dam was formally dedicated early in October.

*716 Franklin street, Boise, Idaho.

Lighting a single black-powder time-fuse by the following method is suggested by the United States Bureau of Mines as being more efficient than the old way of splitting the end of the fuse. It can be used when only one piece is to be lighted, but is not applicable when several shots are to be fired, as the interval between ignitions would be too long. A safety-match is held against the powder core at the end of the fuse and the match-box drawn across the match, causing the match and powder core to ignite immediately. It will be noted that this is just the reverse of the usual way of lighting a match by drawing it across the box. In case safety-matches are not at hand, the ordinary match can be used by placing one match against the powder core, then lighting another and quickly touching it to the first one. It is believed that the method outlined, which was developed by W. C. Cope, of the explosives chemical laboratory of the Bureau in Pittsburg, as the result of experience in the ignition of hundreds of pieces of black-powder fuse, will be helpful in quarrying and other outside work. It has the advantage of cheapness, as no fuse-lighters are required.

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Geology as an Aid to Tropical Engineering

By WARREN D. SMITH*

INTRODUCTION. The purpose of the present paper is, first, to discuss the general geologic processes as they are found at work in the Tropics, contrasting their effects with the same processes in the Temperate regions of the earth, and second, to cite some examples showing their practical bearing upon the engineering problems arising in those regions.

From many years of contact with engineers and their problems, particularly in the case of Tropical countries, I know that often all too little attention is paid by the engineer to the fundamental considerations upon which geology alone is capable of throwing light. This is due frequently to either an entire lack or a narrowness of training. How is it to be overcome? It is hardly to be expected that the engineer-student will be able to put any more geology into his already crowded courses. That, however, is not necessary, for all that is desired is that he realize his limitations and the importance of the bearing of geology upon his work and the need for expert advice. Some engineers in the Philippines with whom I have had the pleasure of working showed that they appreciated this fully. Others did not, and as a consequence they have left monuments to their lack of insight.

Previous to our experience in the Philippines and Panama, we Americans had had no especial contact with the Tropics and consequently many of our engineering data were found untrustworthy when applied to wholly new and unusual conditions. An especially good example may be cited in the location of our highways and railroads. In the United States, we run a railroad line up one canyon over the pass and down the other side by way of another canyon. This has been tried in the Philippines, notably in the Benguet road; the result is that this road will have to be abandoned because of excessive cost of maintenance. In the Tropics, during high water there is room for but one thing in a valley and that is the stream which occupies it; such a feat of engineering as that which has made the Royal Gorge and the Denver & Rio Grande railroad famous is absolutely out of the question.

There is one cardinal rule to be laid down at the outset, namely, take nothing for granted, investigate each problem separately. Handbooks and set formulae are worse than useless; they are dangerous.

I wish to compliment Professors Ries and Watson for giving us their admirable work on 'Engineering Geology.' This book, good as it is, however, does not help us much in the special field we are considering; therefore, I offer this contribution to the subject. There is one other book on this same general subject, by Sorsbie, which I am frank to say was a disappointment to me as it contains little that is either new or specific.

The general topics considered in the following paper have already been broached by me in an article contributed to the Proceedings of the Philippine Society of Engineers and I am indebted to members of that society for many data and much inspiration. The United States may well be proud of her young engineers in the Philippines. Their work may have been less spectacular than the digging of the Panama Canal but political, social, and racial factors have made the Philippine job no less difficult.

GEOLOGICAL AGENTS. The three most important geological agents are:

1. Diastrophism.
2. Vulcanism.
3. Gradation.
   - Weathering.
   - Transportation.
   - Corrasion.
   - Corrosion.

1. Diastrophism. This denotes up-and-down movements in the crust of the earth. Such movements are negligible apparently in the older and more stable parts of the earth, but, even there, they manifest themselves as earthquakes. In the newer parts of the earth and particularly along continental borders they are of great magnitude and importance. As it happens, many of those places are in the Tropics. This is true of both Panama and the Philippines. At least once and perhaps twice before, the barrier of the Isthmus of Panama, which has cost so much in life, labor, and money to cut through, has been overcome by the intermingling waters of the Atlantic and the Pacific and it is not at all impossible that future diastrophic activity will make all our labor useless. However, these movements are so slow as to be almost negligible in any one generation. Only the geodesist finds that he has to readjust some of his calculations.

2. Vulcanism.

As the Philippine archipelago is a part of the so-called Circle of Fire that girts the Pacific Ocean, we naturally expect the vulcanism to be of such magnitude that the engineers would have to be continually anxious. Nevertheless, except for those regions in the immediate vicinity of active volcanoes, little damage has ever been recorded from this cause. The most marked effects were those noted in 1911 resulting from the explosive eruption of the Taal volcano, situated about 25 miles due south of Manila. Had there been a large city the size of Kingston, Jamaica, for example, situated on the shores

*Past-president of the Philippine Society of Engineers; head of the Department of Geology, University of Oregon.

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of Lake Bombon much damage might have been done. The town of Lemery, only a few miles distant, suffered to the extent that an old church made of volcanic tuff was badly disfigured and a triangular section of land, crossed by one of the Government's new highways, dropped about three feet, allowing the tide to come inland for perhaps a half mile. The length of damaged road amounted to about two miles. These effects were due directly to earthquakes and indirectly to the volcano. Although 498 distinct shocks were recorded in Manila, at the time of the eruption practically no damage was noted. The claims of a certain American firm, with a patent type of concrete construction, that none of their buildings had suffered any damage at the time were strictly correct, for no buildings in Manila revealed any weakness.

Another instance in which vulcanism did play an important part was that in which a section of road in one of the provinces was obliterated for a distance of two or three miles by a fall of bombs and a deluge of mud and ashes from the Mayon volcano in 1902.

3. Gradation.

This is the sum total of the wearing-down process—in many respects the dominant geological agency. If we analyze this process we find that the following agents are contributory: a. Weathering; b. Transportation; c. Corrosion; d. Corrasion. I would, however, make 'corrosion' a sub-heading under weathering, there being two factors involved in weathering, a mechanical deformation, and a chemical change, either of which may precede the other. Then once weathering, or, to use a very crude term defining it in part only, 'sleeking' has taken place, transportation comes in and does its work and the 'corrasion' or mechanical wear becomes operative, but not until there is movement.

Of course, these factors are operative in all countries and under nearly all conditions, but gradation probably proceeds at a maximum rate in the Tropics. Two reasons are given for this, namely, rainfall and temperature, or in one word, climate.

In the Philippines we have a mean annual rainfall of over 100 inches, with sometimes exceptional and almost unprecedented precipitation, notably 72 in. in 56 hours on July 29, 1911, at Baguio Observatory, P. I. This record is second only to that recorded at Simla, India.* At such times the streams leave their banks and spread out over the country in sheets of water. Needless to say, the amount of material then transported is almost incalculable. Furthermore we have another factor to consider, namely, the factor of velocity. Often this is not taken into consideration. When we stop to consider that doubling the velocity of a stream means increasing its transportation power 64 times, we realize what a power we are trying to combat. We shall return to this topic.

Once the tropical downpour of warm rain has stripped off the soil, weathering can and does strike deeper into the core of rocks beneath and however far we go underground in mine workings we find the rocks exhibiting incipient decomposition. I know this to be true from the examination of a great many thin sections of wall-rock from the deepest mines in the Archipelago. Undoubtedly the presence of organic acids, resulting from the decay of the rank tropical vegetation, hastens this decomposition. Of course, we have little or no frost, except on the highest mountains, but we do have wide ranges in temperature during the 24 hours and this adds to the disintegrating forces at work. And so all things considered, we have reason to think that gradation is the most potent of the geologic processes at work in the Tropics.

Special Problems. Road-building and maintenance. In the Tropics and particularly the Malay region, the seasons are sharply defined, one of practically no rain and one during which it rains in torrents. If we recall the rule that the carrying power of a stream varies as the sixth power of its velocity, we know at once we cannot take any chances with a tropical torrent. In regions of high relief we have four things to consider and we cannot neglect any one of them. They are:

1. Declivity or head.
2. Sudden increase of volume due to configuration of the valleys.
3. The angle of slope of valley-walls.
4. Material and structure of the valley-walls.

I have seen highways placed in valleys at such points that the road was continually menaced by the stream just below it and by the sliding of material from the slopes above. The stream is dangerous because of two things:

First; the sapping of the water itself.

Second; when the velocity is doubled it can carry particles of rock 64 times as large as before; and in time of freshets, boulders weighing tons are carried along, each one acting as a battering ram. No retaining-wall can be expected to, nor does, withstand this terrific bombardment.

Again, the composition of the country-rock, its structure, texture, and the state of weathering are of vital importance. If the weathering extends to a considerable depth, it will be an easy matter to start slides (witness the Culebra Cut at Panama), and if this weathered material slides into the canyon below, a temporary and very dangerous dam results. When the dam breaks, and it soon must with the impounding of the torrent behind it, all will be swept before it. We have a remarkable example of this in the now famous Benguet road on the island of Luzon. The Bued river is a small stream, little more than a creek in the dry season; it flows from 5000 ft. elevation to the sea. The valley-walls are V-shaped, the average slope being probably as high as 35° or even 40°. The country-rock is a badly decomposed andesite for the most part with some tuff deposits, much jointed and with innumerable small faults, all loosened by many earthquakes. Here we have ideal conditions of instability, which were perfectly ap-

*[These rainfalls are remarkable, but are quite drowned by that of Cherrapongee, in Assam, where an annual deluge of 900 inches is recorded.—Editor.]

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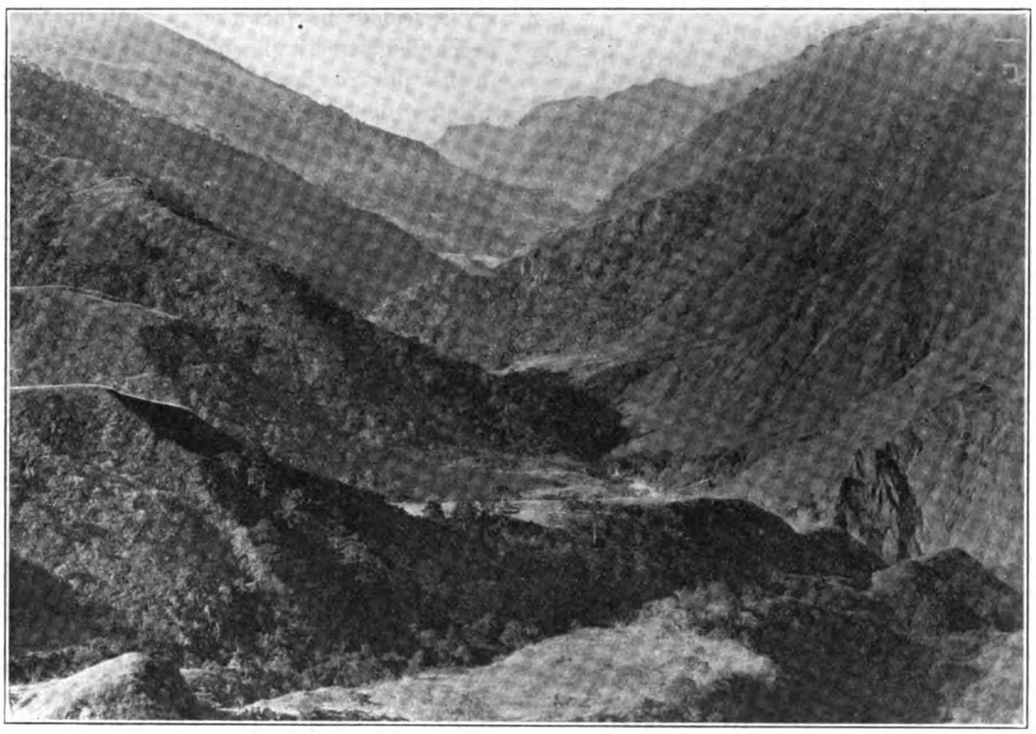
parent to geologists, yet as far as I know, no geologist was consulted by the engineers until it was too late. The inevitable happened. First, slides continued until the slopes reached the angle of repose; then dams followed, impounding the water to a great depth; next, the dam broke and search parties were out looking for the road, buried under sixty feet of debris. Now after many years and spending much money, the road is to be abandoned. And so they are going back to the ridges, following the example of the Spaniards.

On the question of the engineering technique involved in the construction of these roads, I would venture to lay emphasis on the necessity for drainage—keep the foundation of your road drained. You may say that this is nothing new, that every engineer knows that, but the application in America where the rainfall is merely a light summer-shower as compared with the tropical downpour is a different problem. At to how roads should be drained, that is not within my province as a geologist.

Maintenance on a road constructed of poor materials is one thing while that on a road wherein a wise selection of metal has been the rule is an entirely different thing. Right here a geologist with his microscope is a necessity. Petrography, once despised as an academic study, is now indispensable to the scientific road-builder. There is a pathology of rock just as there is a pathology of animal tissue. The microscope will reveal at once, and at little expense, whether or not the minerals composing the rock are sound, whether there is incipient decomposition, or a far-gone state of decay. It will show also the fabric or texture of the rock. If the rock has an ophitic texture, that is, the minerals interlaced to make up a sort of mat, then we may look for toughness. Why one rock splinters and another does not, or why one crumbles rapidly into a powder, is at once made clear.

At one time I collected rock-specimens from a number of places along one of the principal Philippine highways and among the samples was one that yielded a briquet which when placed in the Page cementation machine refused to break under 2000 blows, whereas an ordinary basalt briquet yielded at the 22nd blow. A thin section of the fresh rock was made and examination showed that there was a small amount of secondary calcite in the rock, an alteration-product of the lime-bearing silicates; it was this that furnished the excellent binding qualities. The rock was a diorite just beginning to decompose without having gone so far as to reveal this condition to the naked eye. This rock, with its holocrystalline texture and just the right amount of calcite, would make a most excellent road-metal because it had two essential qualities, namely, toughness and high cementation quality. Of course, the objection of high cost will be raised at once; but no matter how the finances stand, there is never any excuse for putting worthless and unsuitable rock on a road. My plan is this, let the geologist recommend one or more kinds of material and then let the engineer consider which he can afford to use.



A VALLEY IN THE HIGHLANDS OF LUZON.

I am glad to state that that is the way the Philippine Government is doing things, for the advice of the geologist is always considered nowadays by the engineers of the Bureau of Public Works. The Bureau of Science maintains a road-testing laboratory.

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ARTESIAN WATER. The principles governing the concentration and movement of ground-water are now well understood, but, at the risk of repetition, I shall make a few general statements.

First: Although we do not see it, the sea of underground water is almost as extensive and in some ways more important than the ocean. All the rocks, varying in degree of saturation, contain water down to a limiting depth. Some of this water is found in the large trunk-channels, joints, and faults, but a great deal of it is in the form of hygroscopic water, that is, water held in the pores of the rock by capillary attraction. Some rocks, like the dense volcanic flows and quartzites, contain practically no water. Other rocks, like the limestone formations, have subterranean rivers passing through them, but the sandstones and chalks are the most important in this respect. A true sandstone consists of grains of quartz compacted together. The more nearly spherical these grains are, the more continuous are the openings. In such an arrangement of spherical grains there is always a continuous passage through the mass. Along this passage the water travels. Some sandstones have as much as 35% of pore space.

An English geologist, H. B. Woodward, makes the statement that the quantity of water held in the chalk of England by capillary attraction is tremendous. One square mile of dry upper chalk, one yard in thickness, contains nearly 3,500,000 gallons of water, and when saturated holds 200,000,000 gallons.

The loose volcanic tuff formations of the Philippines are also great water-carrying formations. This water is generally circulating slowly in the small openings, but when the water reaches a fissure, naturally the circulation is rapid.

Let us consider the best condition for artesian water. As the deep-seated igneous rocks are usually dense and have but little pore space, and as the fractures of this formation have no regularity, it can be seen at once that this is a poor formation in which to seek water. Water may be traveling along a fissure in this formation, and the well-digger may pechance strike this fissure, but usually the chances are slim. There is no excuse for locating a well in such a formation. A limestone formation is also poor, for while it is cavernous and contains underground streams, it is a pure piece of luck when one of these is struck. The best conditions are found in the sandstone, volcanic tuffs, and beds of unconsolidated ash. Having found the formation, we must next consider some features in the structure of the region. The ideal condition is where the sediments form a syncline (basin) with the water-bearing stratum outcropping at a higher point than the site of the well and where there is an impervious layer of clay or shale just above the water-bearing stratum. The effect of a fault on the water circulation would be to divert the flow to springs at the outcrop, but the effect of an igneous intrusion would be to block the water circulation. All of these things must be examined, if possible, previous to the digging of the well.

It is incredible that even at this late day water should be sought with a divining rod, yet in 1907 an attempt was made to find artesian water with a divining rod in the city of Zamboanga (Mindanao). Water was not found, and an examination of the geology of the country showed that very little chance existed of a supply being tapped within a reasonable depth. In spite of one or two apparently plausible features about the divining rod, the use of this device may be classed with other pseudo-scientific operations such as palmistry and astrology. Besides this case of the Zamboanga well, there is one on record in California where a man spent about $25,000 trying to get a well in a semi-arid district. He never did get water, and a geological examination of the country revealed the fact that a fault in the neighborhood precluded utterly the possibility of water being found in that part of the formation in which he was drilling.

Three or four years ago at Olongapo, Luzon, a well was drilled on the naval reservation, and when I visited the place I examined the cuttings in the drill and found the material to be diorite, which is the basal formation of the island and contains very little water, having no regular continuous water-passages. The well-digger drilled here for 22 months. No water was found, and in the end he lost all his tools in the hole. As the driller was paid by the foot, he, of course, did not have to pay the bill. On the island of Guimaras the same thing has recently been done. In another part of the Islands a well was dug and the water was found to be brackish. An examination was made of the locality, and it was found that the stratum which had been tapped outcropped a short distance away in salt water.

The Bureau of Public Works, I believe, has paid more regard to the geology of the country than any other engineering organization here; and, so far as its wells have been dug in the Manila central plain, good results have been obtained. But I wish to emphasize this fact, that in spite of all the practical experience of a well-driller, there are many more things to be taken into consideration than simply those that pertain to digging the well. The instances in all parts of the world of unwarrantable waste of money are so numerous as to prove that the practical well-driller is not the one to locate a well—he is often thoroughly unpractical. At the present time a special expedition of five geologists and two topographers is at work in Patagonia,† loaned by the United States to the Argentine republic, for the purpose of choosing favorable artesian-well sites for the Government.

The question of health enters largely into the location of wells. It is important to know the structure of the country in order that one may know the direction of drainage and whether or not pollution of the underground streams does or does not exist.

†[We are informed that this expedition found no artesian basins possible; hence, geology was of negative value. But, with American resourcefulness, the expedition turned its attention to topographical and hydraulic engineering; after much hard labor, a supply of water was found in a river that had not been considered previously because it was supposed to flow at too low an altitude.—EDITOR.]

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I am told that in certain parts of the Hawaiian islands water has been found by sinking through the overlying formation, largely consisting of lava, to the ash-beds that lie buried below. The water here is ponded in this loose formation by the coral reef bordering many parts of the islands. The same conditions, no doubt, could be found in many parts of the Philippines.

It is time that there should be some good wells in crystalline rocks, but, as Ries and Watson bring out in their diagrams, the chances of striking a joint or fault carrying water is much less in these compact rocks than in a formation every void of which is saturated with water.

Dams and Reservoirs. The geological conditions affording the best sites for dams and reservoirs have also been covered by Ries and Watson. With reference to this phase of the subject I wish to state that a geological examination of a district and several years of stream-gauging is not only desirable but imperative in the Tropics. I could cite many examples of how these works should not be located, but two or three will suffice. The city reservoir at Montalban was made in a limestone gorge. The limestone is full of caverns and the reservoir failed to hold water until it was lined, bottom and sides, with cement. If the dam had been placed at the upper end of the gorge the reservoir would have had a natural clay bottom.

The destruction of the Tarlac (Luzon) dam probably could not have been foreseen, but if a few more data concerning annual precipitation and stream-discharge had been secured the trouble might have been averted. The Agno river when under full head is a terrible engine of destruction.

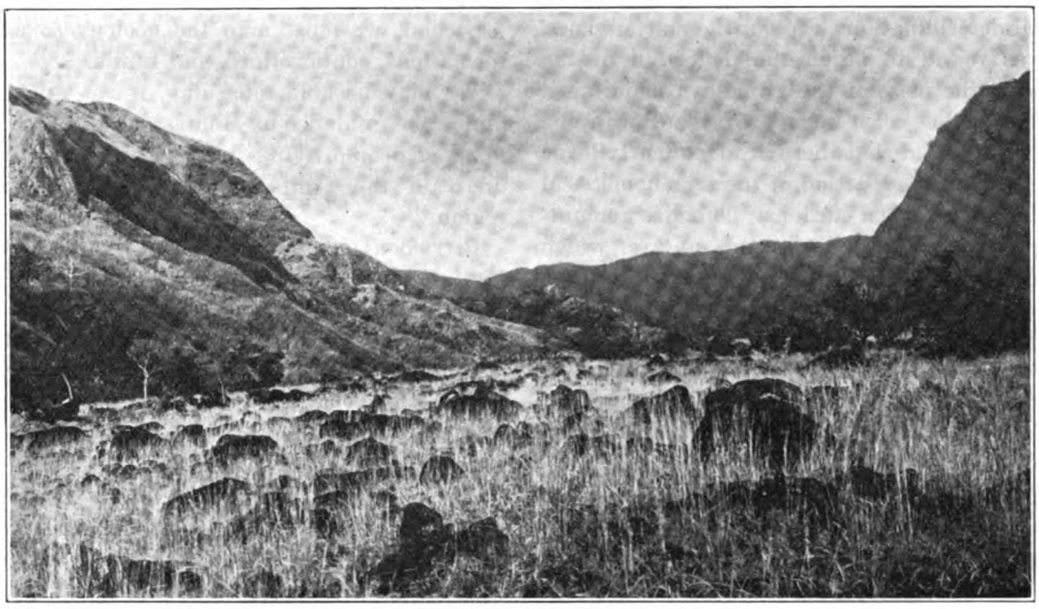
A dam was built in the hills back of Cebu, making use of an apparently substantial formation for abutments and spillway. Drilling was recommended by the geologist who examined it; but no, that would be too expensive. The abutments held in a terrific storm that ensued, but the spillway, which was too small, forced the water down through a decomposed formation which had a hard shell on the outside, so that the dam was useless.

From my observations in the Philippines, I should be inclined to say *never* build a reservoir in the Tropics. If water is needed use diversion weirs in streams or else artesian wells.

Coal Mining. I had intended not to touch on any phase of the application of geology to mining engineering in this article for the reason that the connection between the two is so generally recognized. There is just one point that should not be overlooked here, and it is one that has given more or less trouble to those who would work coal seams in the Far-Eastern Tropics. It has been my experience throughout many years of examination of coal prospects and mines in the Tropics that the persistence of a given seam of coal is always a matter of conjecture. They often thin or 'peter out' just when you are counting on a good working thickness. I have long sought for a geological reason for this and have at last worked out these tentative conclusions:

1. We have great rainfall over most of Malaya today. There is every reason to suppose that this has been the case throughout most of the Tertiary period, which is the age of the tropical Malayan coal.

2. The great deluging downpours of rain mean coarse sedimentation and frequent interruptions to the quiet accumulation of vegetal matter from which we are to hope for a future coal deposit. We do find that the character of the underlying and overlying beds in the neighborhood of these uncertain coal-beds is very variable, coarse and fine strata alternate with no great thickness to any one stratum. So my advice to the engineer or geologist who is sent out to examine a coal deposit in any part



THE RESULT OF TORRENTIAL WASH, IN THE PHILIPPINES.

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of the Tropics is this: examine carefully the nature of the enclosing strata, the character of the grains, size, and arrangement, and take nothing for granted, put down test-holes or drill everywhere in the field, and, better still, drive on your coal.

GEODESY. Over fifty years ago there appeared in the Transactions of the Royal Society several articles by the learned Bishop of Calcutta, a mathematician and physicist of no mean repute, relating to the perplexities then confronting the surveyors in control of the great Topographic Survey of India. This, one of the greatest of surveys, is still in progress. The problem that confronted them was how to account and allow for a very noticeable and very important discrepancy between the trigonometrically located stations and those ascertained by astronomical determinations. To cut the matter short, the trouble was found to be in the deflection of the plumb-bob due to the mass of the Himalaya mountains.

In the course of the coast survey of the Philippine islands, it has been found that there are frequently large discrepancies between the location of the trigonometrical stations and the astronomical stations. This has amounted, in some places, to 30 or 40 seconds of arc, which may mean a matter of half a mile or more on the surface of the earth. How to adjust this has been a matter of some difficulty. The great piles of volcanic rock constituting the Zambales mountains are adequate to explain the discrepancies at some of the stations on the west coast of Luzon. But, at Olongapo, it was found that the plumb-line instead of being deflected to the east was deflected to the west, though the main mass of the Zambales mountains lies to the east. An examination made by me several years ago of the Cinco Picos range, which lies to the west of Olongapo, revealed the fact that these mountains are made up of one of the densest rocks known, the rock called pyroxenite. This rock has a density of over 3, whereas the main mass of the rock in Zambales has a density only of about 2.5. Therefore, apparently, this discrepancy is explained by our knowledge of the geological features of the two regions.

SEISMOLOGY. Earthquakes are not confined to the Tropics. Nevertheless, the regions of greatest seismic disturbance are either within the Tropics or not many degrees removed. I do not know that there is any connection between these facts. It happens that the newer (geologically) parts of the earth are for the most part within this zone. In view of the great engineering works built at Panama, in the Hawaiian islands, the Philippines, and elsewhere, it is of importance to understand the principles controlling earthquake phenomena.

In an investigation conducted for many years by Father Masó of the Philippine Weather Bureau and myself, we found that of the great number of earthquakes in the Philippines from 1599 to 1909, only a comparatively small number could be traced to volcanoes, and that of the 25 seismic districts in the Philippine islands, only five are near or include active or dormant volcanoes, and the two regions of greatest seismicity had no volcanoes at all.

The damage done at San Francisco by earthquakes, the catastrophes of Messina and Avezzano, and the lesser disasters that have overtaken the Philippines from time to time, all force us to pull our heads out of the sand and look facts squarely in the face. Of course, a great deal can be done to minimize these destructive occurrences by proper construction.

There are two things we must do to cope with earthquakes; in the future we shall in all probability do much more—perhaps predict, as is indicated by Perrett's work.

First, build structures completely tied together, whether of bamboo (the best type), wood, or concrete. My preference is for sand-lime brick securely tied to a steel frame.

Second, we must map the geology so as to show all formations, contact lines, and faults.

We may be able some day, if we study these things under the guidance of Montessus de Balore and Perrett, to see a people living in comparative security enjoying unafraid the fruits of husbandry in an earthquake region.

PHYSIOGRAPHIC CONTROL OF ECONOMIC DEVELOPMENT. My last topic is quite different from any of those I have already discussed and does not permit of definite statement nor of exact proof. I shall attempt to show by the citation of three cases how a knowledge of the geologic and physiographic conditions would be beneficial in practical matters, aside from the more obvious applications to mining.

The island of Cebu in the Philippine group is long, narrow, and mountainous. It has an interrupted strip of coastal plan on which practically the entire population of the island may be found. The people are poor and live largely on and by the sea. There is no productive 'hinterland' or back country. Paralleling and for the most part within a few yards of the sea is a first-class macadam highway. With these conditions confronting them a railroad company constructs a third (steel) highway for the most part within a few yards of the first two. Had it not been for the Government guarantee of 4%, this venture would have been a great loss to the investors. The railway never had a chance of success and the guarantee is a conspicuous example of lack of business acumen on the part of the Government.

My second case is that of the now famous Benguet road, already mentioned. I have tried to show how a highway cannot run up a canyon in the Philippines and be permanent. Now the change of location for this artery of travel leaves a big section of the country stranded, but at the same time will tend to develop the other section through which the road will in the future run. In this particular case the coastal tract in the neighborhood of San Fernando de Union (west coast of Luzon) will receive a great impetus.

North of Subig bay (about due west of Manila) there is no first-class typoon harbor on the coast of Luzon. This deficiency is reflected at once in the general character of the coast towns and cities all along this west and

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north shore-line of Luzon. The same is true for a goodly portion of the east coast of the same island and again on the east coast of the great southern island of Mindanao.

I can give a practical example illustrating how this works out: The island Polillo off the east coast of Luzon has some good coal seams—true bituminous coal—and there is a good harbor at Burdeys on this island, but no harbor worthy of the mention anywhere near on the mainland (Luzon). Consequently scarcely any ships navigate these waters. Now we know pretty definitely from investigations made in Borneo that a coal mine in this part of the world must be able to sell most of its coal to passing ships in order to succeed. The coal cannot under existing conditions be shipped to Manila. So here we have the coal industry depending upon the amount of shipping on that coast and that in turn dependent absolutely upon the nature of the coast and the population thereof, all of which go back to geologic and physiographic conditions. And so we often see so-called practical business men making blunders like these because they refuse to consider as practical the advice of the scientific investigator.

COST OF STREET WORK IN OAKLAND, CALIFORNIA

The report of Commissioner W. J. Baccus for the year ended June 30, 1915, contains considerable data regarding street work in Oakland. Part of this information is summarized below:

Street sweeping in the congested district for the past few years has been done under contract with a suction sweeper at a cost of 35c. per thousand square yards. Other parts of the city were swept with an open rotary-broom at 26c. per thousand square yards. Hand-sweeping cost 20c. per thousand square yards, and was also more satisfactory, as more of the work could be done in the daytime, and the streets kept clean nearly all the time, while the machine-work is done at night and the streets are dirty a good part of the day. For these reasons machine-sweeping has been discontinued and the work is now being done by hand.

Since 1911, 90.6 miles of plain macadam and 9.5 miles of turnpike macadam streets have been oiled, at a cost of $121,000. The estimated saving in sprinkling, repairs, and cleaning has been $131,000.

On an average, 90 horses are kept at the city stables at the following daily expense per horse: 4.4 lb. barley costing 5.2c., 0.126 lb. bran costing 0.2c., 2.1 lb. straw costing 1.6c., 24 lb. hay costing 17.1c., 4.2 lb. oats costing 6c., making a total for feed of 30.3c. Labor cost 13.1c. per day, shoeing, 5.6c., and medicine, water, light, etc., 2c., a total of 51c. per day.

With the increased mileage of oiled streets, the expenditure for street sprinkling has been reduced 50% in the past four years, 10,197,660 cu. ft. of water was used, costing $17,391.70, or $1.71 per thousand cubic feet. The total cost of sprinkling was $43,651.95, or $258.81 per mile of street kept sprinkled.

Patching bituminous pavements cost $1.026 per sq. yd. on an average. Of the entire amount laid, 1.3% was replaced during the year, making the average cost for maintenance 13.3c. per sq. yd. Repairs to water-bound macadam cost 1.9c. per sq. yd. laid. Repairing oiled streets cost 0.7c. per sq. yd. laid. Surface oiling cost 5.5c. per square yard.

The cost of permanent paving was as follows; grading, 2c. to 3.5c. with an average of 3c. per sq. ft.; asphalt pavement 17c. to 23c., with an average of 20.3c. per sq. ft., granite curb, $1.43 per lin. ft.; protected concrete curb, 62c. to 85c., with an average of 76c. per lin. ft.; brick gutters, 40c. per sq. ft.; basalt block gutters, 45c. per sq. ft.; concrete gutters, 16 to 20c., with an average of 18.6c. per square foot.

Grading for macadam pavement cost from 20 to 80c. with an average of 41.2c. per cu. yd., or 0.5 to 5c. per sq. ft. One-course oil macadam cost from 6.5 to 12c., with an average of 7.5c. per sq. ft. Two-course oil macadam cost from 6.75 to 18c., with an average of 9.9c. per sq. ft. Redwood curbs cost from 9 to 16c., with an average of 11.1c. per sq. ft. Concrete curbs cost from 30 to 60c., with an average of 43.8c. per sq. ft. Broken-rock gutters cost from 10 to 16c., with an average of 10.8c. per sq. ft. Concrete gutters cost from 10.5 to 17c., with an average of 13.7c. per sq. ft. The cost of cement sidewalks ranges from 9 to 18c., with an average of 10.4c. per square foot.

The cost of vitrified pipe sewers per lin. ft. was as follows: 6-in., $0.35 to $0.75, average $0.595; 8-in. $0.50 to $2, average $0.55; 10-in., $0.60 to $1.10, average $0.87; 12-in., $0.70 to $1.10, average $0.88; 14-in., $1 to $1.50, average $1.10; 16-in., $1.30 to $3, average $1.57; 24-in., $1.55 to $2.60, average $1.97. The average cost of manholes was $39.16 each, of catch-basins and inlets, $29.95, and of lampholes, $10.94.

Forty-three automobiles were in use during all or part of the year. For the cars that were driven more than one thousand miles, the total cost of upkeep per mile varied from 2.6 to 22c., with an average of 7.1c. The distance traveled per gallon of gasoline varied from 8 to 24 miles, with an average of 14.

Cost of repairs and extensions for the San Diego Water Department are given in the report of F. M. Lockwood, city manager, for the month of August 1915. Connecting new ¾-in. services cost $10.29 each, exclusive of meters. Including meters, the cost was $17.80, $12 being for material, $3.48 for labor, and $2.32 for overhead expense. The average length of the connection was 25 ft. Renewals of ¾-in. services on paved streets, cost $11.26 each, $4.89 for material, $4.91 for labor, and $1.46 for overhead expense. On unpaved streets, the cost was $5.18, including $1.72 for material, $2.82 for labor, and $0.64 for overhead expense. The total number of consumers served was 14,810. During the month, 486 services were repaired at a total cost of $712.59, or $1.46 each, and 212 leaks in the mains were repaired at a total cost of $400.54, or $1.89 each.

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The Use of Hydrated Lime in Concrete-Road Building

By L. N. WHITCRAFT*

The problem to be solved in building permanent roads seems, at first thought, to be an easy one. But in consideration of the change which has taken place in traffic conditions during the past generation, the roads which are now being built must be constructed for exceptionally heavy traffic.

A road should properly be built for the future as well as for the present. The highway engineer is therefore called upon to design roads which not only may justly be called permanent under present conditions, but also must be serviceable for the heavier traffic which is certain to come. No road surface is 'permanent' in the strict sense of the word, for all require repairs from time to time to keep them continuously in good condition. Concrete probably approaches more closely to the ideal standard of permanency than any other type of road in general use. As is the case with everything else into which the human factor enters, there are some good concrete roads and some which are not so good. The addition of hydrated lime to concrete will not overcome serious defects in workmanship, but it will materially decrease the danger of building a poor road.

Such defects as cracking, stone pockets, or soft spots, in the concrete slab are probably the most common causes of concrete-road failures. Any treatment or precaution that will eliminate or materially reduce the liability to these defects in the slab will be a great assistance in placing concrete roads in the 'permanent' class. The future of concrete roads depends upon firm adherence to superior quality concrete. Sub-grading and drainage are important, but the final criterion of a concrete road as distinguished from a road built of other material is the integrity and durability of the material itself, the quality of the concrete. In no other structure does the service, to be rendered by concrete, call for such perfect quality of material as in a road.

From tests and experiments, both in laboratory and in actual practice, it has been demonstrated that the fundamental causes of cracking and stone pockets in concrete roads are: first, lack of plasticity and homogeneity of the concrete; second, segregation of the aggregates while mixing and placing; third, shrinkage during the preliminary hardening period from the time the concrete is placed and the time it begins its initial set. During this period, the concrete has no strength to resist shrinkage strains, so that incipient fractures may develop, which later become cracks or lines of weakness. A fourth cause is porosity of the slab, permitting the alternate absorption and expulsion of moisture. This variation in moisture content, affects the volume and produces expansion and contraction, more than mere changes in temperature. Finally, lack of uniformity in the finished concrete results in pockets of material of varying ability to resist wear, and holes and ruts soon appear.

Recent investigations and experiments by prominent engineers looking to the elimination of these defects, have led them to recognize in hydrated lime an effective, safe, and suitable material which may be used as an admixture with concrete to overcome, or at least to minimize these defects. The results also show that the addition of hydrated lime facilitates the handling and placing of the concrete, and is productive of the following results:

1. Increasing the plasticity and homogeneity of the mass, causing the concrete to flow more readily into place, and increasing the covering capacity and spreading qualities of the cement.
2. Reducing the tendency to segregation of the aggregates to a minimum.
3. Causing the retention of a sufficient amount of moisture while the concrete is setting to aid further hydration of the cement and to reduce the risk of shrinkage-cracks.
4. As it tends to prevent voids, rendering the slab less porous and more impermeable, largely reducing the alternate absorption and expulsion of moisture and in this way minimizing expansion, contraction, internal stresses, and cracking, all of which result mainly from changes in moisture content.
5. Producing density and uniformity in the finished concrete, thereby adding to the life and efficiency of the road by elimination of stone-pockets and other sources of irregularity in strength.

Cement mortars and concretes are naturally harsh and coarse-working, and unless they are wet and sloppy they are difficult to handle. In order to overcome this lack of plasticity, sufficient water is frequently added to cause segregation. In addition to aggravating this condition, the excess water prevents the uniform distribution of the cement throughout the mass, upon which the factor of durability of the concrete is more dependent than it is upon the proportion of cement used.

The direct effect of the addition of hydrated lime to cement mortars and concretes is to make a 'fat,' viscous mortar of great plasticity, which is more easily mixed, thus producing a smooth-flowing mass without the marked tendency toward segregation. This lack of plasticity in cement mortars and concretes is largely due to the slow solubility of the cement, for when first mixed they contain practically no colloids, in consequence of which such mortars are 'short' and non-plastic and offer but little resistance to the loss of water, either by gravity

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or by evaporation. The addition of hydrated lime provides the necessary colloid, which, besides retaining the water, makes the mortar or concrete more plastic and easier to work, and reduces the segregation of the aggregates while mixing and placing to a minimum, resulting in a homogeneous, dense, and uniform mass. The affinity of hydrated lime for water causes the mixture to retain an excess amount of the moisture when placed. When no hydrated lime is present, this is usually lost through seepage or evaporation. The excess water enables the concrete to reach its initial set without the development of shrinkage cracks, and aids further hydration of the cement. Cracking in concrete surfaces is not caused so much by temperature changes or sub-grade conditions as by variations in moisture-content.

With cracks in the slab reduced to a minimum, the question naturally arises as to the spacing of transverse joints, or even the necessity for joints. The occurrence of transverse cracking has proved just as erratic in slabs with the joints spaced 30 ft. apart, as in those spaced from 60 to 100 ft. apart, so that with volume-change minimized by preventing the changes of moisture-content it would seem advisable to build concrete roads without joints, except at the end of a day's work. It is not to be expected, however, that a slab of the average thickness and high content of cement now generally specified, can undergo the process of setting without yielding to the shrinkage stresses. It is possible, however, to eliminate such stresses to a great extent by using a leaner mixture, which is less subject to volume-change, and by adding hydrated lime, which prevents voids and porosity of the slab. Laboratory tests to determine volumetric changes have demonstrated that when hydrated lime is added the test-pieces remain practically constant in volume up to the 48-hour period. This fact explains the reduction of the tendency to crack, noted in practical work, as during the preliminary hardening period the concrete remains practically without change of volume, and there is opportunity for the cement to obtain greater strength and sufficient coherence to resist the stress due to shrinkage.

Rendering the mass highly plastic and homogeneous produces density, uniformity, and greater strength in the finished concrete, thereby adding to the life and efficiency of the road, because of uniform resistance to wear.

It is not to be expected that the use of hydrated lime will preclude or overcome the possibility of defects in concrete roads built under unfavorable conditions, but it has been actually demonstrated that the addition of hydrated lime will, to a great extent, overcome such defects as cracking and soft spots as well as generally improving the durability and wearing qualities of any properly constructed concrete road.

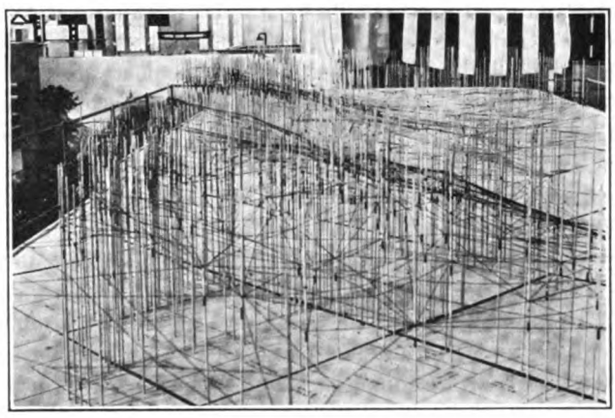
Wire-mesh or metal sheets as foundations for cement or plaster coatings are now required by municipal ordinance in Guayaquil, Ecuador. The old practice was to use split-bamboo laths for this purpose.

MODEL OF SUNSET-MIDWAY OILFIELDS

Above the mineral exhibit of the State Mining Bureau in the Palace of Mines and Metallurgy at the Exposition is a 'peg-model' of the above oil-producing area, arranged by E. B. Latham of the Kern County Oil Protective Association. The purpose of the peg-model is to portray the conditions beneath the surface of the oil-field. It shows (in red) the folding and tilting of the continuous bodies of oil-bearing sands, their relation at any point to the over and underlying water-bearing formations, and their depth from the surface of the ground. This information is of the greatest importance in drilling new wells as it enables the driller to land and cement his casing at the proper depth to exclude water from the oil-sands.

The area covered by this model is 5.5 by 15 miles. The land subdivisions and ownerships are shown on the base of the model. Each peg, of which there are over 1200, represents a well.

The elevation of the top of the peg corresponds to the



VIEW OF MODEL*.

elevation of the well above sea-level, so the tops of the pegs represent the surface of the ground. Sea-level is indicated by a narrow black ring painted on the rods at a uniform height. The important water-bearing sands are shown on the rods in green, and the oil-bearing sands are shown in red. Red strings connecting the rods represent the probable position of the oil-sands.

The exhibit has been installed by the Kern County Oil Protective Association, a co-operative society, organized by the operators in the field for their own protection, chiefly from water infiltrating into the oil-sands. In order to secure uniform and scientific co-operation among themselves, it became necessary to adopt some means of clearly and accurately depicting the underground structure. Many methods were tried, but the peg-model system has proved the best. It is simple, and so easily understood, that mistakes can be foreseen and avoided in future drilling. It has been arranged and exhibited by the Association with the co-operation of the Department of Mines and Metallurgy of the Panama-Pacific International Exposition.

*From photograph by W. W. Bradley of State Mining Bureau.

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The Oil Region of Northeastern Mexico*

By V. R. GARFIAS†

The greater part of the petroliferous area lies in the State of Vera Cruz, the northwest part only being in San Luis Potosi. Vera Cruz is bounded on the north by the State of Tamaulipas, the northernmost of the Mexican states along the Gulf. The centre of supplies for the oilfields is the harbor of Tampico, where the wharves and loading facilities are excellent. From Tampico the National Railways of Mexico penetrate the interior, crossing the northern part of the oil district in a westerly direction. The petroliferous region south of Tampico, lying along the Laguna de Tamiahua and from 20 to 40 miles inland, is reached by water, the points on the coast being connected with the different properties by wagon-roads. The Huasteca Petroleum Company's lands are accessible by a narrow-gauge railroad, 35 miles long, from San Geronimo on the lagoon to the Casiano and Cerro Azul camps. Transportation along the coast and a few miles inland is facilitated by numerous estuaries. The Tamesi, Panuco, and Tuxpan rivers are navigable for many miles, and the properties located near these water-courses are easily reached from Tampico or Tuxpan. The greater part of the machinery and supplies is imported from the United States to Tampico or Tuxpan.

The greater part of the mainland of Mexico is made up of Tertiary and later effusive rocks and sedimentary deposits of Cretaceous age. The igneous rocks form a belt from 150 to 300 miles wide, spurs of which skirt the coast of the northwestern State of Sonora, and after receding from the coast continue to the southeast, crossing the central part of Mexico in a more easterly trend along the general latitude of Mexico City. This igneous belt, which attains its greatest development in the Sierra Tarahumare in Chihuahua, the Sierra Madre in the States of Durango and Zacatecas and in the central states to the north of the City of Mexico, forms the high central plateau which has an average elevation between 5000 and 8000 ft. North and east of this belt along the plateau and down the steep decline to the Gulf extends the larger of the Cretaceous areas, which is folded and contorted along the eastern escarpment of the Sierra Madre Oriental and reaches the coast as a gentle low-dipping monocline covered in places with Tertiaries and a thin veneer of Quaternary. The petroliferous zone is situated on this monocline, which forms the coastal plain along the Gulf of Mexico, its geologic features being modified locally by the remnants or outposts of the belt of effusive igneous rocks to the west.

The formations involved in the geology of the Mexican Gulf coastal-plain oil-territory are shown in the accompanying table, the tentative classification adopted in the present paper correlating the formations, in order of their age beginning with the oldest, as follows:

Tertiary		Pliocene	Quaternary and recent deposits	
		Miocene	Tuxpan	Later Tertiary: Clays, limestones and sands. 700′ ±
		Oligocene	San Fernando (yellow clays, limestones and sands)	
		Eocene	Alazan shales Mendez shales (in part)	Cretaceous-Eocene: Shales. 3000′ ±
Cretaceous	Upper		Papagallos shales Mendez shales (in part)	
			San Felipe limestones and shales	Upper Cretaceous: Limestones and shales. 500′ ±
			Cardenas	
	Lower	Middle	Tamasopo limestone	Lower Cretaceous: Limestones. 3000′ ±
		Lower	El Abra limestone	

1. Lower Cretaceous limestones, comprising a series with an estimated thickness of about 3000 feet;
2. Upper Cretaceous limestones and shales, having an aggregate thickness of about 500 feet;
3. Cretaceous-Eocene shales about 3000 ft. thick;
4. Later Tertiary fossiliferous limestones, sands and clays, about 700 ft. in thickness of Oligocene and later age;
5. Igneous intrusions of late Tertiary or possibly early Quaternary age;
6. A thin cover of Quaternary and recent deposits.

There are slight evidences of petroleum throughout the lower Cretaceous limestones, some of the beds having a slight petroliferous odor. Jeffreys records that in the small pores of the dolomitized limestones, minute particles of petroleum exist, but finds no reason to assume that the oil is indigenous to the limestone. It is evident, however, that these and possibly the underlying beds play an important part in the formation and accumulation of oil, and it is possible that at one time they furnished the organic matter from which the oil originated and from which it was distilled and condensed, perhaps coincident with the change which altered the beds to their present state. It is also probable that the top of this formation affords ideal reservoirs of connected chambers for the accumulation of oil in large quantities. This is particularly true in places where shattering, due to igneous intrusions subsequent to the formation of the effective cap-rock of shales has occurred; or where similar results were obtained

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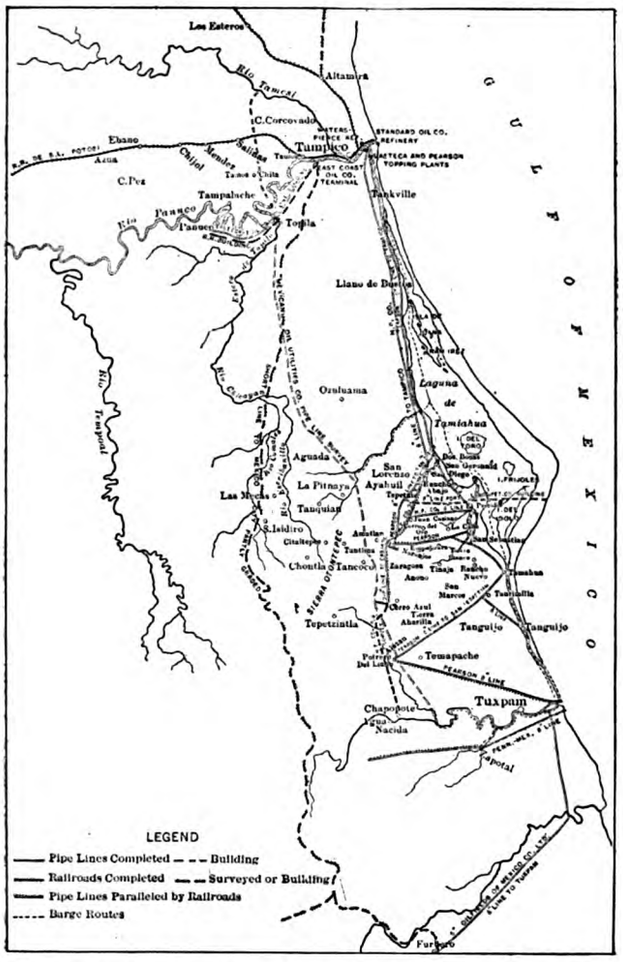
through erosion or other causes previous to the deposition of overlying beds.

There is no doubt that the Upper Cretaceous limestones and shales form one of the most important sources of oil in the region. This formation, of alternating clays and limestones, forms an ideal reservoir, particularly where fractured or folded, as is the case near intrusions. Its stratigraphic position immediately above the supposed source of oil, and thick capping of impervious shales are particularly favorable to accummulation. Most of the wells encounter the commercially productive oil measures below a fairly uniform series



SKETCH-MAP OF THE MEXICAN OILFIELDS, SHOWING PIPE-LINES AND RAILROADS.
(Geology by Geoffrey Jeffreys.)

of shales immediately after perforating minor thicknesses of limestones. As far as the well-records indicate, the main oil reservoir in this region is encountered within the Upper Cretaceous beds.

Although the Cretaceous-Eocene shales are especially important in connection with the accumulation of oil, as affording an effective cap-rock of impervious material above the main oil-reservoirs, they are also a commercial reservoir of oil when structural conditions are favorable. Some of the wells throughout the plain derive oil from these shales, particularly the lower members, without reaching the Upper Cretaceous formations.

Relation to Petroleum. The later Tertiary limestones and sands are of little importance in connection with the commercial accumulation of oil in this region, and merely form a rather porous covering over the impervious Eocene-Cretaceous shales. Under favorable conditions, however, where the shales have been fractured allowing the oil to migrate to the overlying porous beds, accumulations of oil take place within this formation. For the most part the Quaternary formation consists of recent lagoon deposits of shells, conglomerates and sands, which are prominent along margins of the Tamiahua Lagoon, fringing the coast and streams; they are comparatively unimportant.

The marked characteristic of the geology of the Mexican oilfields in this section is the large number and magnitude of the volcanic intrusions, the remnants of which are represented by dikes, sills, and in places isolated basaltic cones, breaking the monotony of the Coastal plain. Most of the surface indications of oil are closely associated with the basalts and hundreds of such phenomena occur throughout the plain.

The intimate association of the igneous intrusions and some of the producing fields is so apparent as to be unquestionable, and the problems in this connection relate chiefly to the effect of the basalt on the structure and texture of the intruded beds which resulted in their being able to store large quantities of oil under tremendous gas pressure.

As the result of certain experiments, I have reached the following tentative conclusions.

The thicknesses of the basalt intrusions as they pass through the Cretaceous-Eocene shales toward the surface increase roughly in a uniform ratio.

The horizontal zone of folding of the shales around the intrusions increases toward the surface.

The horizontal zone of fracturing varies with that of folding, but the number of fractures is greater in the deeper beds.

The fractures seem to occur along roughly vertical planes thus forming deep well-like channels.

These vertical holes, partly filled with basalt and shale, could be effectively capped before reaching the surface, owing to the smaller number of fractures in the higher beds and the increasing cross-section of the intrusion toward the surface.

It is well to emphasize the fact that although the most productive wells drilled to date are situated near intrusions, these are by no means essential to large accumulations of oil, as any cavities below the impervious cap-rock, due to causes other than intrusions, may, under favorable conditions, form reservoirs of economic importance.

Three more or less distinct anticlines running approximately north and south have been traced; one passes near Ebano; another between Mendez and Chila; and the third between Tamos and Ochoa. In the section between Panuco and Topila there are at least two more such folds, and a well-defined line of weakness marked at the surface by oil seepages appears from Otontopec

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to Tantima and from this point to Dos Bocas. Numerous faults occur throughout the plain, and their position is of the utmost importance in the producing fields, marking at times the limit of the migration of oil or water. Owing to the meagreness of surface evidence the structure of the promising areas cannot be worked even approximately, and the value of drilling-data in disclosing the limits of productive zones and the general habit of oil accumulations is of paramount importance.

The first oil wells in Mexico were drilled in 1882 near San Juan Bautista, Tabasco, by Sarlat, but little oil was obtained and the venture was soon abandoned. Between 1900 and 1904 the Mexican Petroleum and Liquid Fuel Company, Ltd., drilled 23 wells in the southern Huasteca and Tuxpan districts with no commercial success. The first commercially productive well was not finished until 1901, when E. L. Doheny and C. A. Canfield commenced the successful development of the Ebano property. Drilling was begun in February, 1901. The first well, which was completed on May 14 of the same year, yielded about 50 bbl. of heavy oil per day.

On the twenty-fourth of December, 1901, the Mexican government issued a law with the object of encouraging prospecting for oil, in which, among other privileges, the free export of products, free import of machinery (on one occasion), and exception from some taxes for a period of ten years were granted to the operator.

Soon afterwards the English engineering firm of S. Pearson & Son, Ltd., started operations on the Isthmus of Tehuantepec in the southern part of Mexico, and in 1906 extended its work to the Huasteca region south of Tampico. On May 12, 1906, this company entered into a contract with the Mexican government for the purpose of exploiting Government lands in the States of Chiapas, Campeche, Tabasco, Vera Cruz, in the southern district of Tamaulipas and Valles county of San Luis Potosi.

E. De Golyer estimates that up to December 31, 1912, 252 wells had been drilled in Mexico since the beginning of the industry, and of these 64 were producing, five of which yielded more than 90% of the total production of the year.

The fields at present producing may be grouped according to their situation into four districts.

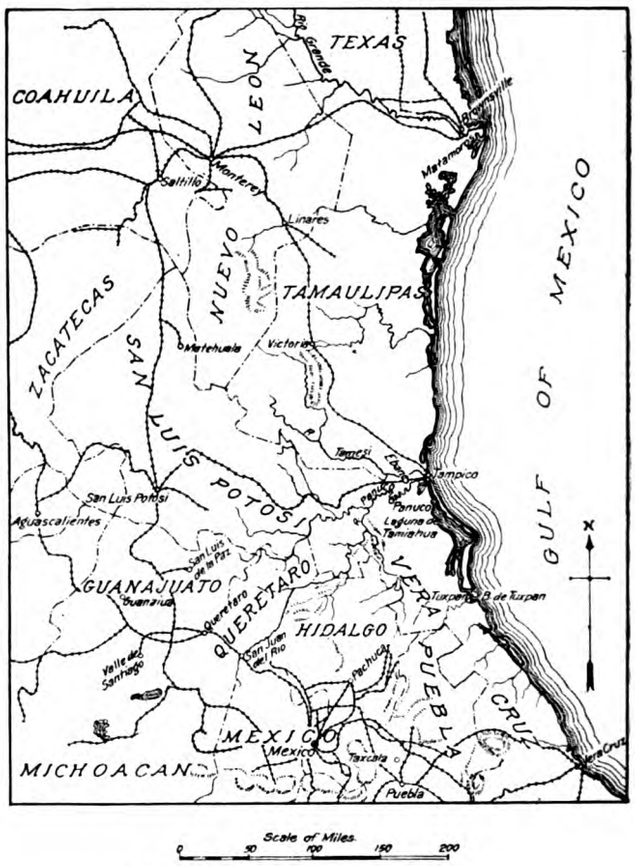
1. The Ebano district, located about 40 miles west of Tampico and comprising the Ebano and Chijol fields, south and north, respectively, on the line of the National Railways of Mexico from San Luis Potosi to Tampico.

2. The Panuco district, comprising the productive areas between the Tamesi and Panuco rivers, of which Panuco and Topila, 20 and 30 miles southwest of Tampico, respectively, are the most important.

3. The Huasteca district comprising the fields south of Tampico and north of the Tuxpan river from the shores of the Tamiahua lagoon to 30 miles inland. The most important fields are the Casiano of the Doheny group, and the Potrero del Llano of the Pearson company.

4. The Tuxpan district, which includes the new fields near the Tuxpan river and the Furbero wells 40 miles southwest of Tuxpan.

Ebano District. The Ebano district comprises the La Pez, Santa Margarita, Laguna, and Chijol groups of wells, the property of the Mexican Petroleum Co. These fields are the oldest in the region and produce heavy asphaltic oil averaging about 12° Baumé. Some of the wells of the La Pez group are remarkable for their longevity and productivity. No. 1 has produced since April, 1904, to date at an average rate of 1500



PART OF MEXICO, SHOWING OILFIELDS.

bbl. per day. The oil from this district is used for the manufacture of asphalt at Ebano and for fuel by the railroads and is transported entirely in tank cars.

Panuco District. The productive areas along the Tamesi and Panuco rivers are included in this district, the most important of which are Topila and Panuco. The bulk of the production of these fields ranges from 12° to 13° Baumé, rendering transportation by pipelines uneconomical. Until this year only comparatively small producers were obtained in these fields, although several flowing wells have been encountered at Panuco and Topila, this last field having suffered somewhat of late by the inflow of salt water. The Panuco field came into prominence early in 1914 with the completion of the Corona well No. 5 in the Pazzi tract with a capacity variously estimated from 15,000 to 100,000 bbl. per

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day. Flowing wells have also been obtained by the Freeport-Mexican Fuel Corporation (Waters-Pierce), the Tampico-Panuco Oil Fields, Ltd., the Producers Oil Company, the Vera Cruz-Mexican Oil Syndicate, and others.

Development has been carried on at several other points with more or less indifferent success, but it is likely that the number of producing fields will soon be increased, particularly on account of the ready accessibility of the region by way of the Tamesi and Panuco rivers which are navigable for many miles through the prospective territory.

Huasteca District. This district comprises the fields south of Tampico and north of the Tuxpan river. The largest producers are the Casiano and Potrero del Llano. Producing wells are also located at Tanguijo, Alazan, Tierra Amarilla, Los Naranjos, Juan Felipe, and Cerro Azul. The Huasteca oil has an average gravity between 19° and 21° Baumé and is easily transported by pipe-lines. In this district are the greatest flowing wells ever drilled, the first one, Dos Bocas No. 3, was completed on July 4, 1908, but immediately caught fire, burning until August 30, when the fire was extinguished during a temporary cessation of the flow. The production of this well has been estimated as being between 40,000 and 100,000 bbl. per day, and in view of the performances of subsequent gushers, it is likely that these figures are not exaggerated. The damage done by this conflagration was enhanced by the poisonous nature of the gases accompanying the oil, Villarello noting that the gas collected in November, 1908, 180 metres west of the well contained 66.5 parts of CO_2 and 22.6 parts of H_2S by weight in 1000 parts of air. The full meaning of these figures may be realized when one considers that from 20 to 25 parts of CO_2 to 1000 of air is dangerous, and that 11 parts of H_2S to 1000 of air is fatal to human life. With the burning of the well the Dos Bocas field was practically ruined and none of the oil produced was ever recovered.

The second Huasteca field discovered was Casiano, which came into prominence with the completion of well No. 7 on September 11, 1910, at a daily rate of about 25,000 bbl. under a pressure of 285 lb. The total production to May, 1915, as given by the officers of the Mexican Petroleum Co., is close to 39,000,000 bbl., which is by far the largest amount of oil ever economically recovered from one well. This record is approached by the Potrero well No. 4 of the Aguila company, situated about 25 miles south of Casiano and 25 miles west of Tuxpan, which is in some ways the most remarkable one of the trio, having produced at times at the rate of 100,000 bbl. per day. The production of this well has been curtailed to meet the transportation and storage facilities available, and for many months it has been flowing from 25,000 to 35,000 bbl. per day, which is the volume that can be handled economically.

Several flowing wells have been finished in this section by the Mexican Petroleum Company, such as Casiano No. 6, rated at 10,000 to 15,000 bbl. in September, 1910, at the time it was closed, when No. 7 was completed. Two wells have been finished at Cerro Azul and one at Juan Felipe said to be capable of flowing about 1000 bbl. per day. The Pearson company has a well at Alazan, second only to the large gushers, another flowing well at Naranjos, and several small producers at Tanguijo and at other points in the region.

The average product of the district ranges between 19° and 21° Baumé. Until the completion of the Corona well at Panuco during the early part of 1914, the Huasteca region furnished the bulk of the oil produced in Mexico, and practically all the oil exported.

Tuxpan District. This includes the fields near the Tuxpan river and the Furbero field to the south, situated 40 miles southwest of Tuxpan and owned by a company which is practically a subsidiary of the Pearsons. The Furbero oil is lighter than the Huasteca product but the wells yield small quantities. Of late the proved area of the Tuxpan district has been extended by the Pennsylvania-Mexican Fuel Co. (Standard Oil group) obtaining a large flow of oil in their Alamo tract south of and near the Tuxpan river about 12 miles south of Potrero. The oil from these wells, being of light gravity, can be readily transported to Tuxpan through the pipe-line which the company intends to put into operation in the near future.

Of the many oil companies registered in Mexico to 1914, it is estimated that only 160 were conducting actual development work in the fields. The present position of these operating companies may be summarized as follows:

1. The Mexican Petroleum Co., Ltd., and subsidiaries (Doheny interests), at present the largest producer and best equipped as regards camps, transportation and storage facilities, etc. This company sells its products mostly in large quantities to American companies along the Gulf states and is but little affected by conditions influencing the local price of oil at Tampico. Of late this company has undertaken to market its products in the United States and has established a distributing depot on the Mississippi river not far from New Orleans.

2. El Aguila Oil Co. and subsidiaries (Pearson interests) with a larger nominal production than the Mexican Petroleum Co., but hampered by insufficient pipe-lines and storage facilities. The oil is refined at their Minatitlan plant, some of the products being sold in Mexico; most of it, however, is exported to Europe. This company and the Mexicon Petroleum furnish practically all the oil used in Mexico and the greater portion of that which is exported.

3. Waters-Pierce Oil Co., which has a refinery at Tampico where Mexican and American crude oil is treated, and producing wells in the Panuco district. This company and El Aguila control the market of refined oils in the Republic.

4. La Corona Oil Co. (Dutch Shell), East Coast Oil Co. (Southern Pacific), Pennsylvania-Mexican Fuel Oil Co. (Standard), and other concerns having strong affiliations and ample market facilities in the United

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States and Europe, and thus are able to dispose of their Mexican product independent of the local market. Most of the lands controlled by these companies are located in the Panuco and Tuxpan districts.

5. Independent companies having no affiliations with any of the first four groups and depending upon small contracts and the local market for the disposal of their products. The properties controlled by some of these companies are in the Panuco and Huasteca districts in comparatively small tracts often scattered over large areas. The 'boom' time of this type of operator is practically over and the most of the oil industry in Mexico has passed into the hands of large financial interests.

Although the commercial production of oil in Mexico commenced the latter part of 1901, it was not until six years later that the figures of the yield were recorded. According to the statisticians of the United States Geological Survey, the petroleum production during these eight years was as follows:

	Barrels.		Barrels.
1907	1,000,000	1911	14,051,643
1908	3,481,410	1912	16,558,215
1909	2,488,742	1913	25,696,291
1910	3,332,807	1914	*27,000,000

*Estimated.

It should be borne in mind that the figures of late years include only that part of the production which can be transported from the fields to market or stored, and represent a fraction of the total yield were the wells now in operation allowed to flow unchecked.

Comparatively little detailed information is available regarding the composition of the different grades of oil produced. Most of the production, which comes from the Huasteca gushers, has an average gravity of 19.3° Baumé and contains about 20% of distillates. The oil produced in the northern districts has an average gravity of 12.6° Baumé and contains about 18% of distillates. The oil produced at Furbero is lighter, averaging about 24° Baumé, and some of the wells at Tanguijo and Cerro Azul produce oil of intermediate grades between that of the large gushers and the Furbero product.

The oil is dark in color and contains sulphuretted hydrogen and carbon dioxide, hence the gas that issues with the oil is asphyxiating and poisonous, and has caused the death of many men.

The temperature of the oil as it comes from the well is about 105°F. at Ebano, 110°F. at Casiano, 132°F. at Potrero, while the emulsion of salt water and oil produced by the Dos Bocas has a temperature of about 160°F. The pressure under which the wells in different properties flow varies from 285 lb. in Casiano No. 7, which is flowing at the rate of about 20,000 bbl. per day; 585 in Casiano No. 6, situated one-half mile due south of No. 7, which is now capped after flowing a few days at the rate of about 10,000 bbl. per day; to 850 lb. per sq. in. in the Potrero gusher, which is allowed to flow a few thousand barrels per day.

The lack of adequate means of transporting the oil from the wells to market has hindered the successful operation of entire districts. Two factors control the transportation of the Mexican oil from the wells to seaboard; (1) the quality of the oil, and (2) the distance of the field from the shipping centres, Tampico and Tuxpan.

The oil produced in the Ebano and Panuco districts is of such low gravity and high viscosity that it cannot be pumped through pipe-lines economically. Its transportation to the market, therefore, can only be accomplished after removing the heavy constituents or asphalt, shipping the fuel oil in tank cars, as is done at Ebano, or transporting the crude-oil in barges, as is the case in the Panuco district. As most of the oil produced at Ebano is used for asphalt and for fuel by the Mexican railroads, its transportation to Tampico does not greatly affect its disposal. The Panuco product, on the other hand, is exported and has to be carried in barges about 60 miles along the river to Tampico where it is stored before delivery to the tank-steamers. Owing to its high viscosity it is necessary to heat this oil before delivering to the barges and again before loading it on the tank-steamers.

The transportation of the products of the Huasteca wells has been satisfactorily solved, particularly by the Mexican Petroleum Co., Ltd., which has a triple 8-in. pipe-line from Casiano to Tampico, and a double 8-in. line from Casiano to the new Cerro Azul camp. The total length of the system is 92 miles and its capacity is estimated at 50,000 bbl. per day. The Potrero field of the Pearsons is connected to Tuxpan by an 8-in. line which has an estimated daily capacity of about 30,000 bbl. Another line of various sizes runs from this property through Tanguijo along the lagoon to Tampico.

Ideal wharf-facilities are available at Tampico where tank-steamers are loaded in record time alongside the companies' storage-tanks. The loading of tank-steamers at Tuxpan is not so efficient, although remarkable results have been obtained, by running lines on the sea-bottom to about a mile off shore, where the steamers anchor and are loaded through flexible piping connected to the submerged lines. The Tuxpan district, or rather the Furbero field, is connected to Tuxpan by a pipe-line with ample capacity to care for the production. The Pennsylvania Mexican Fuel Co. operates an 8-in. line 28 miles long connecting the El Alamo property to Tuxpan and seaboard.

Although the tank-steamers of foreign companies operating in these fields transport Mexican oil to the United States and Europe, the two principal Mexican companies have large fleets. The Mexican Petroleum Co., through the Mexican Transport Co., owns six steamers with an aggregate carrying capacity of over 300,000 bbl. The Mexican Eagle Transportation Co. (Pearson's interest) fleet has an estimated capacity of about 1,000,000 barrels.

The total storage-capacity of the whole region in concrete-lined reservoirs and steel tanks is about 15,000,000 bbl. Of this the Mexican Petroleum Co., Ltd., has reinforced concrete reservoirs with a capacity of

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2,000,000, and steel tanks with a capacity of 8,000,000 bbl. The Aguila company can store 4,000,000 bbl., mostly in 55,000-bbl. steel tanks.

The most important refinery in Mexico is that of the Waters-Pierce Co. (Standard Oil Co.) at Tampico. This refinery distills Mexican crude oil from the Huasteca region, and imports light grades of crude oil from the United States.

The Aguila company owns a refinery at Minatitlan on the Isthmus of Tehuantepec with an estimated capacity of 1400 tons of crude oil per day, and is now constructing a larger plant near Tampico.

The Mexican Petroleum Co., Ltd., operates a topping plant at Tampico, with an estimated daily capacity of 30,000 bbl., and an asphalt plant at Ebano and is constructing a refinery at the distributing depot on the Mississippi, about 18 miles from New Orleans.

Both standard and rotary drilling methods are employed in the Mexican fields. Remarkably good results have been obtained by the use of both. Owing to the impervious nature of the formation overlying the oil-horizon, little or no trouble is experience with water, the main obstacles being due to the sticky character of the shales and to striking oil or gas under tremendous pressure when unexpected. When drilling in these regions it is well to be always prepared to control a flowing well effectively, and, everything else being equal, it is probable that the rotary rig will be found more efficient in controlling these flows.

The development so far has clearly shown the close intimacy between the oil seepages and the underground reservoirs of petroleum, for practically all of the producing wells are within one-quarter of a mile of some surface indication of natural hydrocarbon. A study of the well-records shows at times a striking irregularity in the depth of the oil-reservoirs. Some wells encounter oil a few feet from the surface and others nearby are absolutely dry. The behavior of the producing wells indicates that they derive their supply from different sources, some from porous limestones, others from crevices, still others from the sand shales interbedded with the limestones, and not a few from fractured zones in any formation. Although such wells as Casiano No. 7 and Potrero No. 4 may be duplicated, they should not be used as criteria in judging the possibilities of the untested territory. Undoubtedly many undeveloped areas remain near known oil seepages, and favorable surface evidence is probably at present concealed under the dense vegetation, but any conclusion as to the future productivity and possible extent of these prospective fields can only be conjectural owing to the lack of uniformity in the results so far obtained.

Several promising areas have been tested with negative results, but owing to the large amount of possible oil-territory within the several districts and the great number of districts that have not been tested, it is fair to assume that the present development can give only an indication of the eventual magnitude of the operations and production of the region.

METHODS OF CONSTRUCTION OF CONCRETE ROADS AT BELVEDERE, CALIFORNIA

The town of Belvedere is situated on San Francisco bay about five miles north of the city of San Francisco. It is composed of Belvedere peninsula and Corinthian island, together with a little salt-marsh and beach along the causeway that connects Belvedere with the mainland at Tiburon. The slope of the land on both the Belvedere peninsula and on Corinthian island is steep, approaching 45°. Belvedere peninsula is almost an island itself. Both places are noted both for their natural beauty and for the attractive homes and gardens of the residents. Most of the inhabitants are 'commuters' who are in business in San Francisco, with which there is a ferry service by way of Sausalito or Tiburon.

The topography of the town makes winding roads essential. Considerable plain concrete road and concrete road with an oil screening surface has been constructed in the past, and has given good satisfaction under the traffic, which is now mainly by automobiles, either passenger cars or light delivery-trucks.

The need of an extension of the paved highways was felt in 1914, and a bond issue for $15,000 was authorized by the voters of the town. It was decided to improve about a mile of existing road on Belvedere island, connecting the southerly end of the ridge with the country club and golf links at the northerly end of the island, as well as 1000 lin. ft. of road on Corinthian island. Specifications were adopted calling for a 4-in. concrete base with an oiled screening surface. Contract for the work was awarded April 15, 1915, to F. R. Ritchie & Co. of San Francisco and the work was completed on July 15.

The grading was light, being almost entirely widening the roadbed and reducing grades on existing roads. No hard material was encountered. Payment was made on both cut and fill at $0.90 per cubic yard.

A 1:3:6 mixture was used for the concrete base, using Mt. Diablo cement, sand from the beach near the Presidio at San Francisco, and crushed rock from the quarries of the Daniel Contracting Co. In placing the wearing surface, the concrete was first swept clean and $\frac{7}{10}$ gal. per sq. yd. of oil containing 95% asphalt applied at a temperature of from 150° to 250° F. Then sufficient rock screenings were added to absorb the oil, and to form a coating approximately $\frac{3}{8}$ in. thick. A roller weighing 125 lb. per linear inch, was used until the surface was firm and unyielding. The contract price for the pavement was $1.10 per square yard.

A number of small concrete retaining walls were constructed at different points. A 1:2:4 concrete was used, either crushed rock or gravel being employed for the coarse aggregate. The cost of the retaining walls was $15 per cubic yard.

The width of the highways constructed was 15 ft. The maximum grade is about 12%, and the curvature varies with local conditions, but is nowhere excessive.

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Some Engineering Problems Arising in the Transportation of Natural Gas*

By J. P. FISHER†

Natural gas occurs in portions of certain strata of the earth's surface in areas of comparatively limited extent. It is used as fuel, for the most part, in centres of population and industrial activity. The fields where the gas is found usually happen to be at considerable distances from the points of consumption, making it necessary to lay pipe-lines for transporting the gas. The designing, building, and operation of these transportation systems give rise to many problems of an engineering nature.

In the earlier stages of the industry, the greatest difficulty was experienced in constructing a pipe-line sufficiently good and cheap to make the commercial transportation of gas feasible for any great distances. As better pipe, pipe-couplings, compressing-equipment, and measuring-equipment have been developed, it has become possible to transport gas successfully over greater distances. The limits in improvement in equipment and in knowledge of conditions have not yet been reached, so that the present distances of transportation are in no way final. In the beginnings of the industry no supply of suitable pipe was available, and the joints between sections were so imperfect and so prone to leak that it was found commercially impracticable to transport gas through a pipe for more than a few miles. Various types of pipe-lines were tried. Some lines were laid with cast-iron pipe, having bell-and-spigot joints calked with lead. These lines were fairly good for moderate pressure, but were expensive to construct. Their high cost and the proportionately low pressures permissible made them unsuitable for any great length.

Lines of steel or wrought-iron pipe with screw-joints were the first used to any large extent. In some of the earlier lines, the joints were made with a straight thread; but it was very soon found that the taper thread was greatly superior, both in strength and tightness. Some extensive transportation systems were laid with pipe joined in this way, but a number of serious difficulties arose, the greatest of which was that of making a line reasonably free from leakage. This leakage became greater with increase in length of line, and also with increase in pressures carried, and put a commercial limit on the distance that it was profitable to transport gas. When it was necessary to increase the carrying capacity of a line, pipe of larger diameter was laid without attempting materially to increase the pressure carried. This led, in some instances, to lines of great size. One line was laid to Pittsburg having a diameter of 36 in., and made of steel riveted pipe joined by flanges throughout its length. Such construction was expensive; and, when it is remembered that the field to which a line is laid may not last more than a few years, it is evident that a better method of pipe-line construction was needed. It was not found practicable to make threaded joints in pipe having a diameter greater than 14 in., and even in pipe of this size it was difficult to make tight joints.

Several different types of wrought-iron pipe joints made by calking with lead were tried. Lines laid with such joints were tight at first, but any motion of the pipe from settling of the soil or temperature changes was found to cause leakage. Temperature changes were also found to be a destructive element in a line of pipe connected by threaded joints. Lines laid in the summer often pulled apart in the winter. Where such joints are now used, the lines are laid in cold weather if possible.

To meet these difficulties a new type of coupling was developed, consisting of a centre-piece, which slipped over the ends of the two lengths of pipe to be joined, two glands or end-rings, two rubber packers, and connecting bolts between the two end-rings, the whole forming a double stuffing-box arrangement. This coupling proved to possess many advantages over any form of joint previously used. By its use, a line could be laid that would be practically free from leakage, provided sufficient care was taken during construction. Lines could also be made of lighter pipe and still carry the same or higher pressures than was possible with the threaded joint. This improvement has greatly increased the distance it is possible to transport gas profitably. Although the joint has many weaknesses, it is the best available at the present time. Recently there have been some short lines laid in which the pipe was welded together end to end. This practice is too new to prove its success, but it seems to promise the solution of difficulties due to leakage and deterioration of the rubber-packed joints now commonly used. Like pipe joined by screw-joints, the line is subject to heavy strains due to temperature changes, and it is likely that special provision or expansion-joints will have to be made for this condition.

In the early days, the natural pressure of the gas as it occurred in the fields was the source of power used for its transportation. As the fields neared exhaustion, or when the distances from the fields to the points of consumption were too large, the pressure fell too low. It then became necessary to increase the pressure by

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means of compressors of one type or another. In many of the earlier plants, attempts were made to locate these compressors in the towns and draw the gas through the lines by suction. As could have been easily predicted from theoretical considerations, these attempts failed, and it became the practice to place the stations in or near the fields. At the present time practically every gas-transportation company has to keep a system of compressing-stations in order properly to maintain and control the amount of gas passing through its lines.

Most of the larger natural-gas systems of the country have been the result of a process of evolution in which lines were extended farther and farther to reach one field after another, and in which one compressing-station after another has been built, usually for the purpose of putting gas from a declining field into the main trunk-line. Another factor in this evolution has been the necessity of small companies combining in order to go to greater distances for a common additional supply when the old sources of supply were exhausted. As conditions have changed, some of the equipment becomes useless in its present location, and sometimes it is possible to alter lines so as to utilize old equipment for a new purpose.

The Cushing field is one of the main sources of supply in the mid-continental region. When first developed this promised to be a long-lived source of supply. At that time, however, the gas was found mostly in the Wheeler sand, at a depth of about 1500 ft., and some oil was found with it. The presence of oil in a field is always somewhat of a menace to the life of the field as a gas supply. This is largely because it is cheaper and easier to produce the oil and allow the gas to waste in the atmosphere. When oil-wells are so situated as not to be convenient to a gas-line, the gas is not marketable, and is considered as a by-product of small value by the oil-producer. In many instances, oil can be produced without pumping simply by allowing the gas pressure to blow it out.

In the Cushing field, oil and gas were discovered in a deeper sand several months after the production of gas from the field had been begun. This caused an active development of the deeper sand for oil, and large quantities of gas were allowed to waste in the air. Not only this, but in a great many instances the wells were cased and packed so carelessly that the higher-pressure gas in the deep sand followed the casing to the lower-pressure strata above, where it was dissipated and was no longer available for commercial purposes. By proper means, it is possible to drill oil-wells and produce the oil with scarcely any waste of gas, but it costs more.

It is estimated that the amount of gas escaping in the Cushing field is about 400,000,000 cu. ft., or 11,000 tons per day. This would be equivalent in fuel-value to a train-load of coal of 300 to 400 cars of average capacity. Of the gas in this field, only about 10% ever gets into a pipe-line or is used as fuel. The problem here is mostly one of proper government and control, so far as the community at large is concerned, and of finance, so far as the transportation company is concerned.

As the gas in the Cushing field comes from the well, it is very far from pure or from a perfect gas. It is composed largely of methane, with considerable quantities of the heavier hydro-carbons, ranging from ethane through the C_nH_{2n+2} series, including those which at ordinary atmosphere conditions are vapors and are considered as part of the gas proper, down to heavy oils, and often salt water. The liquids are held in suspension as a fog or mist, or else run along the bottom of the pipe and collect in low places. Between these extremes are all those compounds usually known as gasoline or flashy gasoline. Dirt, sand, etc., are also often present.

The first problem in the transportation of this gas was to separate dust and dirt, and such liquids as water, oil, or gasoline. For this purpose drips or separators were provided in the lines from the wells to the main trunk-line. These drips vary widely in design, but are all intended to catch and store the water and oil until the patrol-man can blow the line out to the atmosphere. The simplest drip is a tee with the opening down, connected with one or two joints of pipe as storage for the liquid that accumulates. This serves fairly well for any liquid not held in suspension in the gas, but, of course, does nothing towards removing the suspended liquid. A great many attempts have been made to remove this suspended liquid, usually by a separator working on the centrifugal principle; but it is a difficult matter to remove the last traces of liquid in this way, and, so far, efforts in this direction have been only partly successful. A new type of drip has recently been developed in California, but it has not yet been fully tried out. Any liquid not taken out by the field drips tends to collect in low sections of the line, and drips should be provided at all these low points. If pockets of liquid occur in the line, they cause the flow of gas to be pulsating instead of steady. This pulsation is difficult to overcome entirely, and is one of the chief sources of trouble in the operation of measuring-stations.

Gasoline and oil are the main cause of rapid deterioration in the joints in the pipe-lines, which are usually packed by rubber or composition rings. The oil and gasoline attack the rubber rings quite actively, and sooner or later cause leaks and blow-outs, especially as the pressure carried in the line is from 200 to 400 lb. per sq. in. Several substitutes for rubber are being tried and these seem to be more resistant; but the only way to eliminate trouble from this cause is to keep gasoline and oil out of the line.

Gas entering the main trunk-lines is often measured by orifice-meters, and many points come up in connection with the practical use of these. In order to compute the amount of gas passing an orifice-meter at any instant, it is necessary to know: first, the temperature of the gas; second, its gravity; third, the size and coefficient of orifice; fourth, the absolute pressure of the gas passing the orifice, and, fifth, the differential, or drop of pressure in the gas in passing through the orifice. The temper-

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ature is practically constant at any given time of year. A mean temperature for the year is usually the contract basis on which gas passing a measuring-station is computed and purchased.

The gravity of the gas is variable, even for gas coming from a given field; and when it is considered that gas passing a measuring-station may come, in varying proportions, from several fields, the importance of making frequent determinations of the gravity of the gas passing a station to ensure accurate metering is evident. The gravity of gas varies in practice from 0.59 to 0.72, taking air as unity. It is determined by comparing the time for a given quantity of gas to flow through a small orifice with the time required for the same volume of air to pass the same orifice with the same head causing flow, and computing from the formula $G = \left(\frac{t\ \text{gas}}{t\ \text{air}}\right)^2$.

So far as the writer is aware, nearly all gas companies, as well as companies manufacturing orifice-meters, have been inclined to assume this gravity factor constant at 0.60 or 0.64. In all orifice-meter measurements, as well as computations of line-flow, or of Pitot-tube measurements, corrections should be introduced for the gravity of the gas. In most of these computations the quantity will vary inversely as the square root of the gravity.

An idea of some of the problems incident to a compressing-station may be obtained by a consideration of a typical compressing-station of approximately 3000 hp., which is capable of compressing 40,000,000 cu. ft. of gas per 24 hours through three stages and delivering it at 350 lb. gauge pressure. Up to this station the gas is transported by the natural field pressure. The prime function of the station is to re-compress the gas, which has dropped to a pressure too low for economical transportation, to a pressure high enough to deliver the requisite quantity through the remainder of the line to the points of consumption.

One of the chief problems is that of the condensation of gasoline in the line beyond the station. As the gas leaves the field, its pressure has been diminishing and its capacity for carrying gasoline as a vapor increasing. There is, therefore, little danger of deposit of gasoline in the line between the field and the compressing-station. In this 40 miles of line practically all liquid has been removed by the drips along the line.

At the compressing-station the pressure of the gas is raised to 300 lb. per sq. in. or higher, and its temperature raised to from 210 to 240 degrees Fahrenheit. After compression, the gas is passed through a cooler consisting of a number of pipes in an open pond of water. Only occasionally is the temperature in the cooler low enough to condense out any great proportion of the vapors condensable at this pressure and line-temperature. A separator is provided at the outlet of the cooler, but it can remove only the vapors already condensed. It is, therefore, apparent that there is a possibility of further condensation of gasoline in the pipe-line beyond the compressor-station. This is exactly what occurs, and it causes a heavy depreciation in this part of the line. In one case, gasoline taken from a drip beyond this station was used in an automobile, and it was found that the exhaust smelled very strongly of burnt rubber. This would not ordinarily matter were it not for the fact that this same rubber has been dissolved out of the pipe-joints, where it is very greatly needed.

From a theoretical standpoint, it is entirely possible, by well-known processes, to condense and separate this gasoline before it enters the line. When it is considered, however, that there is 800 or 900 tons of gas passing this station every day, and that the gasoline content is small, it is seen that the equipment necessary would involve a considerable investment. The problem therefore becomes a commercial one of whether or not the necessary equipment can be installed with an investment small enough to be profitable. This problem will be special for each particular case, and is one which in most instances has not yet been solved.

Continuous accurate measurement of all gas into and out of the whole system is one of the problems of operation of any transportation company. In order to safeguard against loss due to the failure of any of the measuring apparatus, it is necessary to check up in all possible ways the quantities of gas passing the meters. In some cases this can be done by line-flow formulae, and in some by the displacement of compressing-stations. It is found necessary and advisable to use both these methods wherever possible. The pipe-line formula used is of the form $Q = K\sqrt{P_1^2 - P_2^2}$ where Q is the quantity of gas, and K is a constant depending on the length and diameter of the pipe-line and the gravity and temperature of the gas. The formula for flow of gas through an orifice-meter is of the form $Q = K^1\sqrt{hP}$ where K^1 is the constant of the orifice-meter. In checking a meter by line-flow formulae, the quantity involved is the same. Therefore, by equating the two expressions and reducing, the expression $\left(\frac{K^1}{K}\right)^2 = \frac{P_1^2 - P_2^2}{hP}$ is derived. The ratio of the squares of the constants for any line and meter can be evaluated and is a constant. To check the meter against the line-flow formula, it is then simply necessary to evaluate the expression $\frac{P_1^2 - P_2^2}{hP}$ and compare it with the constant derived as above. This check is so simple that meter-station operators can easily make it and report the meter out of order, if the value figured is found greatly different from the constant.

It is well to point out here that if observed pressures are correct, the pipe-line formula can never show an amount of gas passed less than the actual, but is apt to show a greater amount, due to excessive pressure-drop from leakage or from an obstruction in the line. The displacement of a compressor-station gives a basis for comparison with the quantity of gas as shown by a measuring-station which may show up defects in the operation of either. If the amount of gas measured indicates a volumetric efficiency of the compressors greater than 90%, it is safe to say that the measuring-station instruments are over-measuring the gas.

One important function of a natural-gas line is the equalization of the rate of production. The demand for

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gas in a city varies greatly from hour to hour of the day, being several times as great in the daytime as at night, and also varies greatly with atmospheric temperature. It would be a difficult matter to vary the output of a compressing-station or a field at a distance from a town to meet the widely varying demand, if it were not for the equalizing effect of the transmission-line. When the supply is greater than the demand, the gas is being stored in the line, and is available when the demand

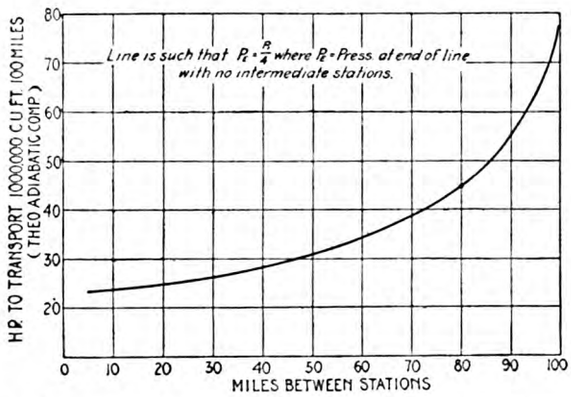

FIG. 1. CURVE INDICATING RELATION OF DISTANCE BETWEEN COMPRESSING STATIONS TO POWER REQUIRED.

suddenly becomes much greater than the rate of supply. Often this equalizing effect will enable gas to be taken into the line at a uniform rate from the field for days at a time, while the demand at the other end of the line is fluctuating widely. The adjustment of supply to demand over the whole of a large system is an art in itself. It is necessary that all production shall be regulated from a central point by a dispatcher, who is in constant communication with all points of demand throughout the system.

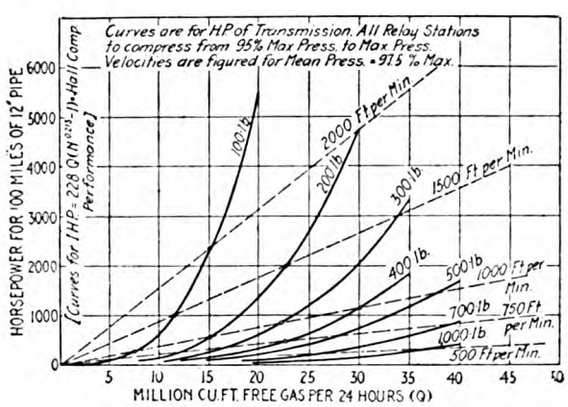

FIG. 2. CURVES SHOWING POWER REQUIRED FOR TRANSPORTING GAS AT DIFFERENT PRESSURES AND VELOCITIES.

Finally, regarding the problem of transporting gas by means of pipe-lines and compressing-stations, our gas-fields are not only stores of latent energy in the form of fuel, but also stores of latent energy directly available as power in the highly compressed state of the gas. At present the pressure-energy is used quite wastefully in the transportation of the gas itself. If, instead of allowing the pressure of the gas to drop to a third or a fourth of its initial value before re-compressing it, the pressure could be maintained at a high point, a great reduction in the total power required to transport the gas could be made. This would point to smaller compressing-stations located at shorter intervals along the line. These stations would require less total power than stations at greater intervals performing the same service, and they could be simplified greatly by the omission of the after-cooler, as the smaller range of compression would not raise the temperature of the gas to an objectionable point. The curve, Fig. 1, shows the economy in power possible by more frequent stations operating through a smaller pressure-range.

The curve in Fig. 2 has been prepared to show the relation between the amount of power required to transport different quantities of gas, the pressure at which the gas is transported and its linear velocity. In this case, the power is assumed to be applied at such frequent intervals along the line that the drop in pressure between the points of application of the power is only 5% of the initial pressure. In other words, the pressure is maintained nearly constant, and the power applied represents the friction loss in the line at the pressure shown. It is seen that both the power required and the amount of gas vary directly with the linear velocity of the gas in the line. Also, that the power required to transport a given quantity of gas decreases as the pressure at which it is transported increases, showing that there would be a great saving if tighter lines could be constructed, so that higher pressures could be carried safely and without excessive leakage.

THE WEST OKANOGAN VALLEY IRRIGATION PROJECT

The construction of a large irrigation-system near Oroville, Washington is now under way. The work is being done for the West Okanogan Valley irrigation district, and the area to be irrigated comprises 10,000 acres on both sides of the Okanogan river, extending southward about 25 miles from the International boundary. Exclusive of the distribution system there will be 67 miles of main conduit, including 38 miles of earth canal, 24 miles of wooden flume, and 5 miles of wood-stave pipe. Contract for the entire work has been awarded to A. Guthrie & Co., Inc. of Portland, Oregon, for $511,650. The cost for water will be $63 per acre.

J. C. Stevens of Portland is chief engineer for the district, and D. C. Henny, also of Portland, is consulting engineer.

Costs of street work in San Diego, California, are given in the report of F. M. Lockwood, city manager, for the month of August 1915. Street cleaning by vacuum sweepers cost $2.92 per mile swept, by rotary brooms $6.33, and hand sweeping cost $2.57 per mile. Repairs to asphalt pavement cost 10.7c. per sq. ft. and repairs to sub-base cost 11.7c. per sq. ft. During the month, 2517 miles of street was sprinkled, at a total cost of $3521.10, or $1.40 per mile.

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The Cost of Maintaining Production in California Oilfields*

By M. E. LOMBARDI†

The cost of maintaining the production of an operating oil-company is one of the most important, as well as one of the most difficult to estimate, of the various items which go to make up the total cost of producing oil. In the opinion of many operators the cost of drilling and developing new wells, whose production takes the place of the loss in production through decreased yield of the old wells, is considered an operating expense, for the reason that the total income-producing power of the property is not increased. The cost of these new wells may be added directly to production expense, or it may be charged to capital account, and this account depreciated to the same extent. In either case, after an oil company is on a satisfactory income-producing basis, the money for drilling new wells to maintain production must be taken from the income of the company. Three factors determine the cost of maintaining production: first, the rate of decline in yield of the wells; second, the cost of drilling and equipping new wells in terms of their production; third, the decrease in initial production of new wells as the property is drilled and gas pressure taken off the sands, etc.

In order to check theoretical figures for the cost of maintaining production I have compiled the following figures with the assistance of Reed Bush and Fred Tough. It is necessary first of all to choose a period of time during which production for the field or territory studied remains fairly constant. The longer the period of time over which this condition prevails, the better. It is also necessary to eliminate or to allow for any extraneous condition which may have affected the production returns, such as the shutting in of a large number of wells, the completion of a well of exceptionally large yield, or the opening of virgin territory where the 'flush' yield is greater than will be obtained from new wells in after years.

All these conditions are exemplified most simply in the case of the Coalinga field, and perhaps these figures are more accurate than the other two cases given. In applying these figures to the future it is well to assume that the average yield of new wells will constantly decrease, since the flush-production period is past for most of the territory. On the other hand, the cost of drilling will decrease, owing to general improvement in methods and particularly to the increasing use of the rotary drill. Although a great many estimates must be made, the results check closely enough to be interesting and possibly of value. The data used are from the records of the Producers' Agency, the *Standard Oil Bulletin*, and various private sources.

The figures for the number of wells at the beginning of the periods include producing wells only, but all wells drilled during the period, whether profitable or not, are included in the calculations, provided they are within the accepted limits of the field—not simply 'wild cats.'

In the Coalinga field the period from August 1, 1912, to July 31, 1913, was chosen. The production-curve is shown in Fig. 1. It will be noted that the production during these 12 months was remarkably uniform, the

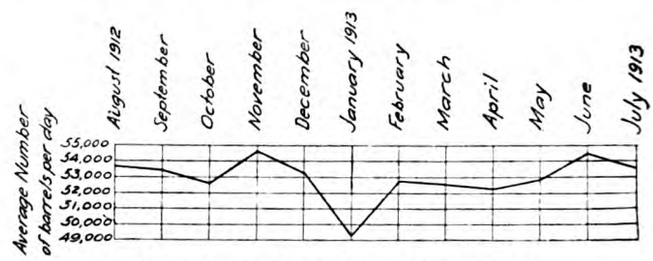

FIG. 1. PRODUCTION-CURVE FOR COALINGA FIELD.

Total production for period, in barrels	19,313,000
Wells completed for period	78
Estimated total cost of these wells	$2,176,573
Cost of wells per barrel produced	$0.1126
Number of wells at beginning of period	843
Proportion of new wells to maintain production per year	9.33%

greatest variation from the average being 8% and the average variation on a monthly basis 2.8%. During this period 19,313,000 bbl. of oil was produced and 78 new wells were completed. The number of wells suspended during the period varied from 176 to 214 out of a total of 843 wells at the beginning. These wells were 'off' from natural causes, and were not to any extent intentionally shut in. The greatest variation from the average number of wells suspended was only 8.6%, so that this factor of wells shut in is not of great importance in the results.

The main facts are, that at the beginning of this period 843 wells were producing, and that, in order to maintain the production of these wells, 78 new wells had to be drilled. To arrive at the cost of these 78 wells, representing the cost of maintaining production, the new wells were classified in four groups. The actual cost of 95 wells in this field, also divided into groups of similar characteristics was accurately known. These average-cost figures applied to the 78 wells in question showed their cost to be approximately $2,176,573. This cost includes derrick and rig, well, flow-tanks and flumes, gas engine or other local pumping equip-

*Presented at the meeting of the American Institute of Mining Engineers, San Francisco, September 1915.

†Flood Bdg., San Francisco, California.

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ment, but not such items as storage facilities, pipe-lines, or main power-plants. If this figure is divided by the total number of barrels produced during the period, we find that 11.26c. per barrel of oil produced is the cost of maintaining production in this field. The number of wells necessary to maintain production for one year was in this case 9.23% of the total number of wells producing at the beginning of the period.

In the Sunset-Midway field the period from November, 1913, through November, 1914, was chosen. Fig. 2 shows that the production was more than maintained, that is, that it was higher at all times during the period than at either end. The Lakeview No. 2 gusher was

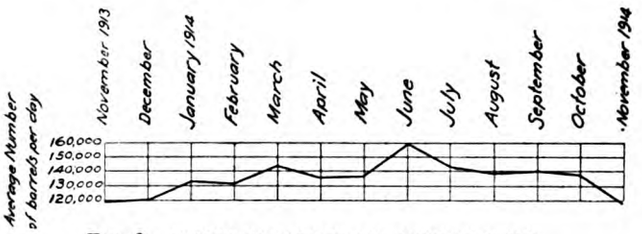

FIG. 2. PRODUCTION-CURVE FOR MIDWAY FIELD.

Total production for period, in barrels	52,799,118
Wells completed for period	189
Estimated total cost of these wells	$4,966,270
Cost of wells per barrel produced	$0.096
Number of wells at beginning of period	1,177
Proportion of new wells to maintain production per year	14.8%

completed in May, 1914 with a production of about 25,000 bbl. However, the greatest variation of the average production was not more than 10.5%. During this period seven gas wells were drilled. These are not included in the figures given, as it is assumed that they were drilled to produce gas only, and no attempt made to produce oil. During this period, a wide-spread agitation occurred in favor of limiting production, and a good many wells were closed in. The probable production of these closed-in wells was estimated as closely as possible and added to the actual production of the field, in order that this intentional decrease should not affect the results, which are of necessity based on normal flow from each well.

The total oil produced was 52,799,118 bbl. including estimated shut-in production, and 189 wells were drilled during the period. The cost of these 189 new wells was estimated in the same manner as for the Coalinga field. The costs of 100 wells in various parts of the Sunset-Midway field, were applied to the 189 wells with due regard to the situation of each well, etc., the same items being included as in the case of Coalinga. The resulting estimate is $4,966,270 for maintaining production during the period, which amounts to 9.6c. per barrel of oil produced.

The proportion of new wells necessary to maintain production for one year in this case is 14.8%, which is a considerably higher figure than for Coalinga, although the cost per barrel produced is less. This is explained to some extent by the fact that a larger number of new wells in the Sunset-Midway field were drilled in shallow and 'easy' territory in the northwestern part of the field, with a correspondingly low cost per well.

A study was next made based on the production of the whole State of California for a period of 15 months beginning August, 1913. During this period, as shown in Fig. 3, the greatest variation from the average production was only 7.5%, which is remarkably small considering the period. At the beginning, 6069 wells were producing and during the period 562 wells were completed, costing approximately $13,559,000. This figure for the cost of new wells is not as accurate as desired, because I am not familiar with the cost of wells in some of the smaller fields. Average cost figures taken from over 250 wells in four fields were used. During the period approximately 130,067,730 bbl. of oil was produced, and dividing the cost of the new wells by this production, we find that the cost of maintaining production was 10.4c. per barrel of oil produced. This differs from the Coalinga figure by only 0.86c. per barrel, and from the Sunset-Midway figure by 0.8c. and is nearly a mean between the two. It is also interesting to note that the number of wells necessary to maintain production over the whole State for one year was 8.22% of the wells producing at the beginning of the year, which corresponds closely with the figure of 9.23% for Coalinga.

FIG. 3. PRODUCTION-CURVE FOR ALL CALIFORNIA FIELDS.

Total production for period, in barrels	130,067,732
Wells completed for period	562
Estimated total cost of these wells	$13,559,000
Cost of wells per barrel produced	$0.104
Number of wells at beginning of period	6,069
Proportion of new wells to maintain production per year	8.22%

It is interesting to apply the data given above to estimate the cost of maintaining production in terms of the average daily production. For example: A company operating average properties in various fields, having a daily production of several thousand barrels, may wish to estimate from a general average how much money will have to be appropriated per year for new drilling to maintain its production. In the following calculations the average daily production for the whole period is assumed as the production at the beginning of the period. In Coalinga the daily production may be thus assumed as 52,912 bbl. at the beginning of the period illustrated above. It, therefore, cost $40.38 per barrel of daily production to maintain production dur-

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ing the ensuing year. Likewise for the Sunset-Midway field, the figure is $33.70, and, for all fields in California, $38. In this case, as in the case of the cost per barrel produced, these figures show the cost for wells and their immediate appurtenances only: The cost of extension of pipe-lines, new permanent power-plants, camps, water-systems, etc., must be added. A fair figure for these is between 12 and 20% of the cost of wells.

If we apply the cost figures used above to all wells producing at the beginning of the various periods shown, the apparent depreciation in earning power of investment during the ensuing year is shown by the ratio of new wells to old. In Coalinga it is 9.23%, in the Sunset-Midway field 14.8%, and for all California fields 8.22%. These figures apply only to wells producing at the beginning of the period. No account is taken of past failures or abandoned wells. Also the figures show an average depreciation for wells in all stages of life. It is well known that new wells fall off in production as much as 50% in their first year, whereas wells five or six years old decrease slightly in comparison. Many of the new wells which maintained the production during the period illustrated were in practically virgin territory in the extension of the known fields, or in new fields, and their initial production was correspondingly high. This condition will not continue long, and for future use it will be safe to discount the results given above.

Concrete Poles for Trolley Service

The report of the Committee on Power Distribution presented before the convention of the American Electric Railway Engineering Association at its meeting in San Francisco in October 1915, gives the results of an extensive study of concrete poles. At Rochester, New York, there are 1600 poles in use. They are octagonal in shape, and taper from a diameter of 12-in. at the base to 9 in. at the top. About 2500 poles are used at Syracuse. These are square at the base, tapering to octagonal at the top, with a diameter of 13 in. at the base and 7 in. at the top. At Cleveland, Ohio, there are 2200, similar in shape to the Syracuse poles but 11 in. at the base and 6 in. at the top. Several poles were tested to failure by attaching a cable near the top of the pole and pulling by a car through a block and tackle. The general results of the tests and of experience are summarized by the committee as follows:

1. Failure of a pole is always due to stretching of the reinforcing rods on the tension side.

2. A failure is always preceded by the appearance of hair-line cracks in the concrete on the tension side, at frequent and regular intervals from the ground line to the top.

3. It is advantageous to use a high grade of reinforcing steel to secure the maximum tensile strength.

4. Plain round reinforcing-rods are as satisfactory as twisted or other rough rods because in general the rods will elongate before they slip in the concrete.

5. A larger number of small rods is preferable to a smaller number of large rods as a better distributed reinforcement may be secured for a given amount of steel and a greater bonding contact-surface is presented to the concrete.

6. The reinforcement need not be uniform throughout the length of the pole, but may be reduced as the top of the pole is approached.

7. A pole with uniform reinforcement will break at the ground-line, while one with tapered reinforcement will break at some point above the ground, depending upon the taper of the reinforcement.

8. Failure of a pole will not in general allow it to fall to the ground. It is difficult at times to pull over a pole after failure, even though it is inclined at a large angle from the vertical.

The report also contains the following description of the method of manufacturing concrete poles at Rochester, prepared by C. L. Cadle.

The concrete-pole yard is in a portion of a working gravel-pit, this situation being chosen on account of the gravel being particularly well adapted for concrete work and on account of the gravel-pit being on one of the lines where a large number of poles are used. It is necessary to haul other materials approximately four miles from the company's steam-railroad terminal. The pole yard occupies a space of approximately 50 ft. wide and 300 ft. deep. There are three 30-ft. forms with six extra bottoms; two 35-ft. with two extra bottoms, and three 45-ft. with six extra bottoms; all are laid on concrete stringers to prevent the form from being warped. Running along the side of the yard the entire length is a spur track for convenience in handling material and the finished product. A three-ton gantry-crane spans the pole yard and track is laid so it can be operated the entire length. All heavy materials are handled in this manner. With each form there are two extra bottoms. This is desirable as the sides of the forms can be taken away from the pole three to five hours after the pole has been poured. The sides are made interchangeable so that approximately two poles can be made each day with the same set of forms. Poles from 27 to 30 ft. are made in the 30-ft. forms by blocking off the required length at the top of the pole. Any length of pole between 30 and 35 ft. can be made in the 35-ft. form in the same manner and any pole between 40 and 45 ft. can be made in the 45-ft. form by blocking off the bottom of the form. This gives practically a continuous range in the heights of poles from 27 to 35 ft. and from 40 to 45 ft., which covers the majority of the different heights used on the road.

In the manufacture of a pole the rods are first made

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up into a form before they are set into the pole-form, the rods being laid on stringers for ease in handling. The bottom half is then placed in a semi-circular rack having grooves for holding each individual rod in its proper position. Cast-iron rings of the proper diameter $\frac{1}{8}$ in. thick and $\frac{3}{4}$ in. wide and having recesses cut in the outside of the circle are provided for the purpose of holding the rods in their proper position. These rings are wired to the bottom rods, the top rods then being placed in their respective recesses, which hold the reinforcement in circular form. The separators are placed 5 ft. apart, the rods being held in the separators by wrapping two turns of No. 12 iron wire around the outside of the rods at each separator. The form is then handled by inserting a $\frac{1}{2}$-in. forged ring with a handle and small lug on the bottom at intervals of 10 ft. or less. Three men pick up the reinforcing rods and set them on the bottom of the pole-form. A small foot on the forged rings holds the rods the proper distance from the bottom of the pole-form. The sides of the form are then placed in position and the rods further held in position by fastening the handle of the forged rings to the top of the pole-form, the form now being ready to pour. The concrete is mixed wet, by hand on a mixing board, and carried by means of a steel bucket to the form. The bucket has an opening in the bottom for allowing the concrete to pour out easily. The bottom end of the pole is poured first and, as fast as it fills, the rings supporting the rods are taken out allowing the reinforcing rods to be held in position by floating in the concrete. After the concrete has been poured, the top is leveled off and the pole allowed to set at least three hours, after which time the sides may be removed and used over again. Before the pole is rolled off the bottom, it is necessary for it to set at least three days. Great care must be used, however, in rolling the pole over so as not to break off the edges. The poles are then allowed to cure at least ten days before they are moved. They are then placed in piles, being handled by a steel beam strapped to a pole and raised by means of the crane. Poles require curing for at least thirty days before setting. It is better to give them a longer time.

The concrete mixture used is one part cement, two parts sand and two parts gravel. The proportion of sand and gravel is not measured by volume but taken directly from the gravel-pit, the average run being approximately one-half sand and one-half gravel. The gravel is run through a $\frac{3}{4}$-in. screen, which allows no stones larger than approximately $\frac{1}{2}$ in. in diameter to be used.

The yard above described has a capacity of six poles per day and is handled by one foreman and five men. The laborers work ten hours per day at 18 cents per hour and the foreman works ten hours per day at $27\frac{1}{2}$ cents per hour. It requires two men approximately all their time with the exception of the time when the poles are being poured to get the rods ready for the forms.

The following costs do not include interest and depreciation on forms nor on the original cost of the pole yard:

Height of pole in feet.	Labor.	Material.	Total.
27	$2.08	$4.83	$6.91
30	2.68	5.76	8.44
35	3.17	6.54	9.71
40	4.40	8.35	12.75
45	4.82	9.23	14.05

CEMENT DRAIN-TILE IN ALKALI SOILS

An investigation has been conducted by the Bureau of Standards, Department of Commerce, during the past year, into the durability of certain cement mixtures in the manufacture of drain-tile to be used in alkali soils. The Bureau states that drain-tile made from cement mixtures leaner than one part cement to three parts of aggregate should not be used in places where the character of the alkali and concentration are similar to that found at the site of the experimental drains that it has maintained at Grand Junction and Montrose, Colorado, and Garland, Wyoming. It expresses the opinion that subsequent results may show that no leaner mixture should be used in any district where appreciable alkali is found. It has found, however, that drain-tile manufactured of one part cement to four parts of aggregate, the leanest mixture used, has apparently been unaffected structurally by exposure for one year in an operating drain in situations where the character of the alkali and the concentration are similar to those found at Fort Shaw, Montana; Sunnyside, Washington; Yuma, Arizona; and Roswell, New Mexico.

The results are given in detail in *Technologic Paper* No. 44, issued by the Bureau of Standards, on this subject. The work is being done in co-operation with the United States Reclamation Service, the Drainage Division of the Department of Agriculture, and the Association of American Portland Cement Manufacturers. The Bureau of Standards would be pleased to receive information concerning the behavior of concrete exposed to strongly alkaline soil which may come to the attention of engineers or others interested in the use of concrete under these conditions.

The work of investigation comprised the manufacture of 9000 drain-tiles of 16 different varieties, their shipment to projects in Colorado, Wyoming, Montana, Utah, Washington, Arizona, and New Mexico, and to fresh-water projects in Minnesota and Missouri, and their installation in operating drains in districts where the alkali is greatly concentrated and in most cases where concrete failures were reported to have occurred. The extension of this work included the placing of concrete blocks in most of these districts, as well as in others in South Dakota and Nevada. Several tiles of each type are removed from the drain each year and tested at the site in a portable tile-testing machine. Conclusive results probably will not be available for several years.

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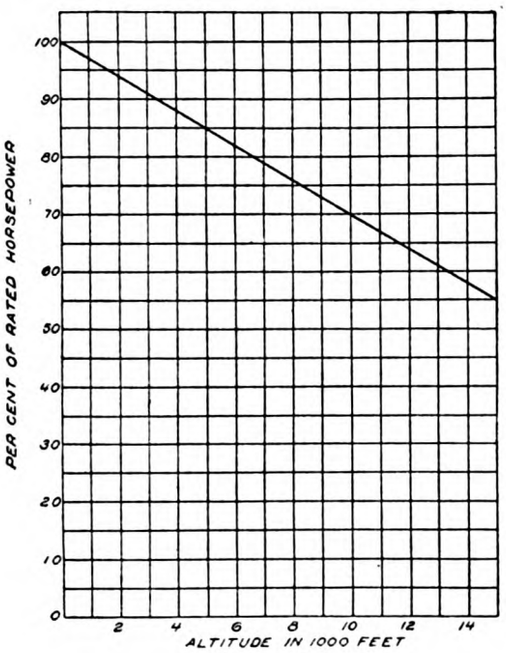
Engineers' Note Book

CHART FOR COMPUTING HORSE-POWER OF GAS-ENGINES AT DIFFERENT ALTITUDES

The horse-power that can be developed by an engine at a given altitude can be computed by multiplying the horse-power



at sea-level by the atmospheric pressure at the given altitude and dividing by the atmospheric pressure at sea-level. Thus to compute the power developed by a 250-hp. engine at an elevation of 8000 ft., we have the pressure at that elevation equal to 10.9 lb. per sq. in. Then $\frac{250 \times 10.9}{14.7} = 185.3$ hp.

The calculation is simplified by the use of the accompanying chart, which is taken from *Practical Engineering*.

Hints on Practice

CONCRETE 'BREAKERS' TO PROTECT ROAD SURFACES

A novel device is used in Maryland to prevent the washing of road-shoulders and gutters, according to H. G. Shirley, chief engineer of the Maryland State Roads Commission. These breakers consist of low-concrete barriers extending from the edge of the road diagonally through the shoulder to the ditch. They are built flush with the surface of the road-shoulder, and where highways are patrolled and shoulders kept in repair, are no obstruction to travel. The Maryland breakers are 12 in. wide and 18 in. deep. Spacing varies with the nature of the soil, the grade of the road, and the amount of water to be handled. It would probably be necessary to space them closer at the bottom of a hill than at the top. On 5 to 6% grades and medium soil the breakers are spaced 25 to 30 ft. apart. Where the soil is liable to wash and the grade is steep, they should be spaced closer. The length as well as the grade of a hill influences the spacing. The illustration shows a macadam road with a concrete breaker extending across the shoulder of the road in the immediate foreground, while beyond appear additional breakers, the spacing in this instance being approximately 25 ft. In general, local materials can be used to build the breakers. A great deal of repair work of costly nature is occasioned by torrential rains, resulting in serious washouts, and judging from the success obtained by the use of the breakers in Maryland they would be an economic investment in other parts of the country where rainfall is sometimes concentrated and concrete materials may be obtained at reasonable cost.

VIEW SHOWING BREAKERS.

Industrial Progress

USE OF MOTOR-TRUCKS FOR 30-MILE HAUL TO MAGNESITE MINE

Motor-trucks are now being used for hauling fuel oil and supplies from Livermore, California, to a magnesite mine situated 31 miles to the south, returning to the railroad with sacks of magnesite. Five-ton Moreland trucks are used. For the test-trip six tons of fuel-oil were loaded on the truck, at Livermore. The trip out, which includes ascending a grade eight miles long and varying from 5 to 15%, was made in six hours. Returning the next day with a load of magnesite, the trip was made in five hours. Later a regular schedule was arranged so as to permit two round trips per day to be made. Formerly the hauling had been done with steam traction-engines or with horses at an approximately equal cost. With horse-hauling, three days were required to make the round trip from the mine to Livermore, as against six round-trips in the same time with a motor-truck. With horses the cost of hauling was $6 per ton, while for the truck it is $1 per ton.

EXHIBIT OF ARMCO IRON CULVERT MANUFACTURERS AT PANAMA-PACIFIC EXPOSITION

The joint exhibit of the American Rolling Mills Co. and the Armco Iron Culvert Manufacturers is situated in the Palace of Mines on 7th street between Avenues C and D. On one side is shown a corrugated culvert installed under a highway and on the other there is a culvert under a railroad track. Other parts of the exhibit show corrugated culverts for irrigation flumes and headgates, as well as exhibiting other uses of these culverts and corrugated iron in general on the farm and elsewhere.

A model is shown of a farm where all the buildings and other structures are made of corrugated iron instead of some

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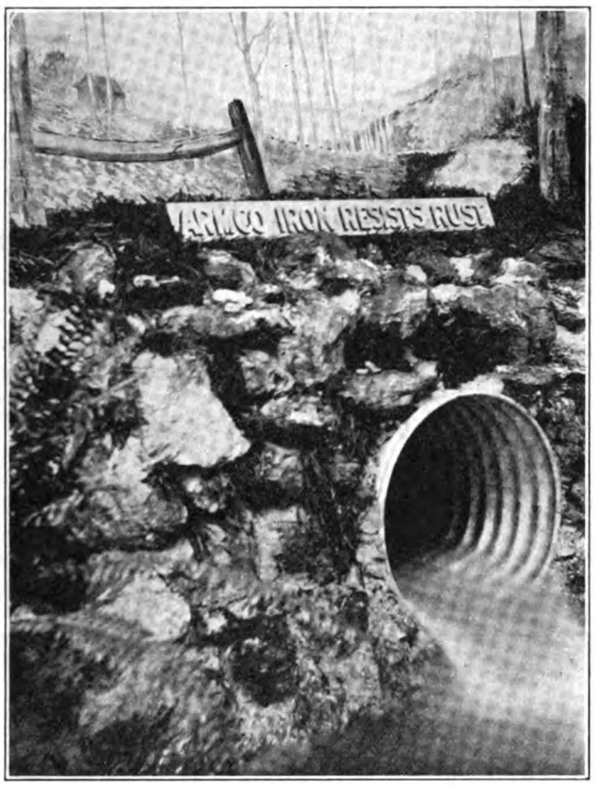
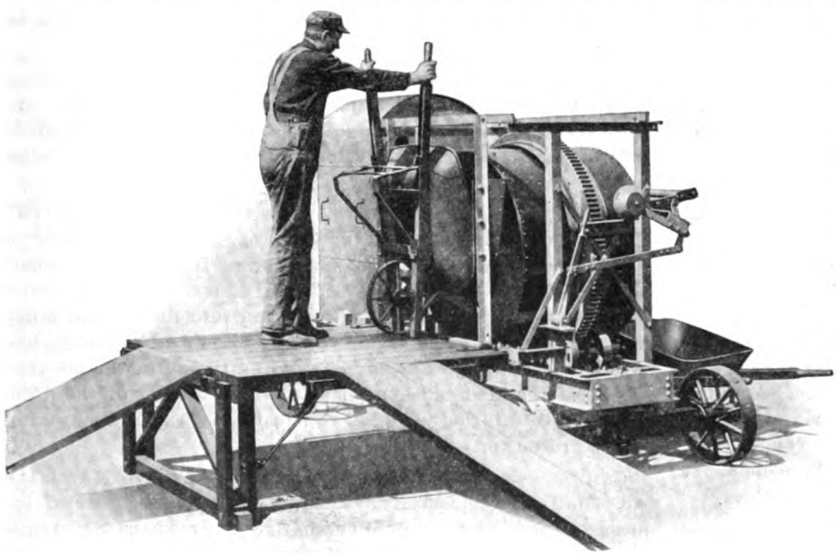
less permanent and fire-resisting material. The 'Armco' brand of iron, besides being employed for corrugated products, is



also used for the manufacture of stoves and many other articles of use in the interior of a house. The purity of the iron ensures a long life for any article made from it.

THE SMITH-CHICAGO LOW-CHARGING MIXER

Low-charging mixers have been in use for a number of years, but the introduction of the vertical-acting power-charger has tended to restrict their field. Recently, however, concrete



VIEW OF LOW-CHARGING MIXER.

contractors have begun to realize that there is a field for both the power-charging mixer, and for the mixer that can readily be charged by hand. The T. L. Smith Co., of Milwaukee, has recently brought out a mixer with a convenient low-charging device. It is made in four sizes with capacities from three to nine cubic feet of unmixed material using from 2 to 6 hp. Wheelbarrows can be used on short plank runways and can be dumped directly into the drum as shown in the illustration. A narrow hopper is arranged so that when a wheelbarrow is up-ended, it fits into the hopper and empties directly into the drum. Splashing, one of the most common of mixer-difficulties, is avoided by increasing the width of the drum and adding a short wing on the feed-side of the blades. These wings bring the material away from the feed-opening and toward the centre of the drum. The mixer is of all-steel construction.

PUMPS AT THE EXPOSITION

The large exhibit of the Krogh Pump Manufacturing Co., San Francisco, in the Palace of Machinery at the Exposition is attracting considerable attention. It consists of a varied line of centrifugal and turbine pumps of the most modern design. The principal exhibits are as follows:

One two-inch single-stage centrifugal pump direct connected to a 5-hp. motor, running at 1800 r.p.m. This pump has a capacity of 100 gal. per minute against a pumping head of 95 ft. It is set on four 1¼ in. steel balls on an ordinary wooden table, and special attention is drawn to the fact that this unit is not bolted down to any foundation, yet when working no vibration is perceptible, even though operated against a closed discharge. The Krogh automatic balancing arrangement, as embodied in all designs of Krogh centrifugal and turbine pumps, is absolutely fool-proof, needing no adjustment whatever, no matter what the condition of suction or discharge, and no set-collars or thrust-bearings are required.

Other pumps in operation are the Krogh deep well turbine of the regular and combination types. The particular features of these are that the rotating parts are carried by the automatic hydraulic water-balance, without the use of the usual heavy thrust-bearing at the top.

Another type that arouses interest is shown in the small vertical submerged type sump pump which is entirely automatic in operation.

The mining features of this exhibit are strikingly shown in the Krogh motor-driven sinking and station-pumps, Cornish and jack-head pumps, and the well-known Krogh slime and tailing pumps, all of which are well spoken of by large mining companies.

The exhibit is very complete, as it includes pumps from 26-in. size, with a capacity of 25,000 gal., down to those of about 10 gal. per minute, and for such varied uses as reclamation, drainage, fire-pressure systems, city sewerage, irrigating, mining and sugar factory work. The Exposition Jury awarded Krogh pumps several gold medals. The Exposition grounds and buildings get their entire water supply through Krogh pumps.

ELECTRIC LOCOMOTIVES AT THE EXPOSITION

The absence of the mule is noticeable in the Mine which is a prominent feature of the Palace of Mines and Metallurgy. In his place the visitor is shown the simple and efficient electric mine locomotive. There are two of these 'electric mules' shown, one in the metal section, of the storage-battery type 24-in. gauge, and one in the coal. section which is 42-in. gauge, and of the trolley, gathering-reel type. Both locomotives are of the well-known bar-steel frame construction of Baldwin-Westinghouse manufacture. The gathering-reel locomotive is of five-ton

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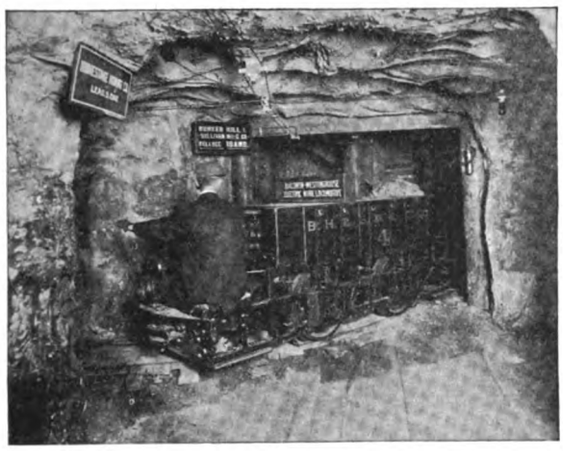
capacity, having two No. 903 motors for 250-volt service, and operates by means of the gathering reel in and out through a pair of automatic opening doors with a load of coal. This reel



ELECTRIC LOCOMOTIVE UNDERGROUND.

automatically pays out the cable on the outbound trip, and gathers it up on the return. The Westinghouse Electric & Mfg. Co., East Pittsburg, Pennsylvania, supplied all the motors used in the mine.

Book Reviews

HANDBOOK OF MATHEMATICS FOR ENGINEERS. By L. A. Waterbury. Second edition. P. 213. Ill., index. John Wiley & Sons., Inc., New York. For sale by the MINING AND SCIENTIFIC PRESS. Price, $1.50.

The present edition is a few pages larger than the previous one, but errors have been corrected, and revisions made. New and important additions deal with hydraulics and reinforced concrete. The book, which is of vest-pocket size, is intended for reference, not for a text-book. Subjects are grouped under algebra, trigonometry, analytic geometry, differential calculus, integral calculus, theoretical, mechanics, mechanics of materials, hydraulics, and 105 pages of logarithm tables, etc.

PRACTICAL SURVEYING. By Ernest McCullough. D. Van Nostrand Co., New York. P. 395. Ill., index. For sale by MINING AND SCIENTIFIC PRESS, San Francisco. Price, $2.

There are many books on elementary surveying published every year. Usually they cover the subject fairly well and are much alike. The present volume differs from the general type in a few particulars. Important among these is a much fuller discussion of the retracement of old surveys than is usually found. This is commendable. Against this, may be set the fact that the mathematical tables are sprinkled through the book instead of being collected in a convenient place at either the front or the back of the volume. Also the work is not pocket-book size, and is bound in material that would not stand field usage. In fact, while the volume is a fair text-book, it is entirely unsuited for use in the field. A curious feature of the book is a short appendix on algebra.

STEAM-BOILER ECONOMY. By William Kent. John Wiley & Sons, New York. P. 709. Ill., index. For sale by MINING AND SCIENTIFIC PRESS, San Francisco. Price, $4.50.

Considerable attention has been directed to the fact that while there are a number of exhibits of internal-combustion engines at the Panama-Pacific Exposition, practically no attention has been paid to steam-engines. It has been suggested that while the internal-combustion engine is still in its infancy and new discoveries are being made every day, the steam-engine has become practically standardized and there are few new developments that are worth exhibiting. So, in the fourteen years since the first edition of this standard work appeared, there have been no remarkable developments in either the use or the design of steam-boilers, but there has been sufficient progress in details to justify a second edition. Greater efficiencies as well as higher duties are obtained than were the rule fourteen years ago, and the principal changes from the first edition deal with progress along these lines. Considerably more space is also devoted to oil as a fuel than in the former edition, although there are some statements as to the limitations of this use of petroleum that are more correct for the Eastern than for the Pacific Coast or Gulf States.

The general chemical and physical facts of combustion are first discussed and then the properties of different kinds of fuel. The next chapter is devoted to furnaces, methods of firing, and mechanical stokers. Boilers are then considered, from the plain cylindrical boiler up to the more modern types. Boiler-design and accessories to boilers are then taken up, and boiler-troubles. Methods and results of steam-boiler trials are discussed, and then the properties of steam and the design of chimneys. The last chapter is devoted to miscellaneous subjects. Perhaps the best way to describe the book is to say that it is as comprehensive for the present time as was the first edition, for the period when it appeared.

New Publications

THE COST OF PUMPING WATER. The DeLaval Steam Turbine Co., Trenton, New Jersey. Contains several useful charts for the computation of pumping efficiencies, etc.

STATISTICS OF RAILWAYS, 1904-1914, UNITED STATES. The Bureau of Railway Economics, Washington, D. C. P. 67. Contains statistical tables of all kinds as indicated by the title.

THE REINSCH-WURL SCREEN. The Sanitation Corporation, 50 Church street, New York. P. 23. Ill. Describes this screen, which is used mainly for the clarification of trade-wastes.

MACK TRUCKS IN WAR MANEUVERS. International Motor Co., 64th street and West End avenue, New York. P. 36. Ill. Gives data regarding the performance of automobile trucks at the recent army maneuvers at Plattsburg, New York.

BOLINDER'S CRUDE OIL ENGINES FOR AUXILIARY TRADING VESSELS. Bolinders Co., 30 Church street, New York. P. 25. Ill. Describes the engines manufactured by the company and gives information regarding the vessels upon which they are being used.

GEOLOGY AND OIL RESOURCES OF THE WEST BORDER OF THE SAN JOAQUIN VALLEY NORTH OF COALINGA, CALIFORNIA. *Bulletin* 603 of the United States Geological Survey. By Robert Anderson and Robert W. Pack. P. 215. Ill., index. This is a report of the first comprehensive investigation into the oil and other mineral possibilities of this region. A good deal of money has already been spent 'wildcatting.' While the authors state that surface indications at some points are favorable for the accumulation of oil, their general conclusions are not encouraging to the prospector.

CEMENT AND CONCRETE, INSPECTION AND TESTING OF MATERIALS FOR HIGHWAY BRIDGES, INSPECTION OF CREOSOTED TIMBER, INSPECTION AND TESTING OF PAVING BRICK, STANDARD SPECIFICATIONS FOR STEEL RAILS, AND ENGINEERING DIVISION, ROBERT W. HUNT & CO. Robert W. Hunt & Co., Chicago. The first five of these booklets give specifications and directions for testing the various materials. The sixth describes the work of the bureau of inspection and tests maintained by the company. Any of the booklets may be obtained upon application to the nearest office of the company.

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Construction News Summary

PRESENT STATUS OF ENGINEERING PROJECTS ON THE PACIFIC COAST

(Engineers and others connected with construction work are invited to make use of these columns to acquaint other members of the profession and the general public with the progress of work under their charge.)

GOVERNMENT RAILROAD IN ALASKA

Twenty miles of railroad has been completed and progress has been made on other parts of the line. Work has now practically ceased for the winter.

GENERAL CONSTRUCTION IN MONTANA

Transmission feeder-line for Chicago, Milwaukee & St. Paul electrification has been completed from Maudlow to Motel, 17 miles east of Deer Lodge. It is probable that electric trains will be operated between Three Forks and Deer Lodge before the end of the year.

GENERAL CONSTRUCTION IN WASHINGTON

Branch of Chicago, Milwaukee & St. Paul railroad between Port Angeles and Port Townsend has been completed and placed in service. Highways between Auburn and Enumclaw and Redmond and Snoqualmie have been completed and accepted. Highway between Kelso and Carrols has been completed. For the season about to close, 227 miles of new state highway will have been completed, 71 miles has been surfaced, principally with gravel, and the 44-mile Snoqualmie Pass division of the Sunset highway, affording the first opportunity for automobile travel between Eastern and Western Washington, has been opened.

GENERAL CONSTRUCTION IN OREGON

Willamette-Pacific railroad, a branch of the Southern Pacific railroad from the main line to Coos Bay points is nearly completed. Rails have been laid on all but 19 of the 124 miles of line, and most of the bridge work, which has been heavy, has been completed. Willamette Valley Southern railroad, extending from Oregon City to Mount Angel, 32 miles, has been completed. The financing of this road was done mainly by the farmers living along the line. Of the 70 miles of pavement to be laid on roads in Multnomah county under the recent bond issue of $1,250,000, 50 miles has been completed. Work on the remaining 20 miles will in general have to be finished next spring after the embankments have been given time to settle. Government dredge 'Chinook' has completed channel 1000 ft. wide and 36 ft. deep across bar at mouth of Columbia river. Columbia River highway has been completed through Clatsop, Columbia, and Hood River counties. This opens the Columbia River highway from the city of Hood River to Seaside on the Pacific Ocean, and the road is all in good condition with the exception of a small stretch on Rainier Hill, which is now being repaired.

GENERAL CONSTRUCTION IN CALIFORNIA

Government dredges working on Sacramento river near Collinsville removed 468,000 cu. yd. of material during the month of September. Three dredges are at work building a levee along the Sacramento river from Colusa to Knights Landing, which will form the eastern boundary of the new West Side reclamation district, containing 119,000 acres. Following sections of State highway have recently been completed and accepted: Hornbrook to Oregon state-line, Woodland to southerly boundary of Yolo county, San Juan Capistrano to Gallivan in Orange county, Morando to Diver in Humboldt county, Hazel Creek to Lamoine in Shasta county, Cordelia and Fairfield in Solano county, Alcatraz to El Capitan creek, San Jose to northern boundary of Santa Clara county, Hopland to Ukiah in Mendocino county, Bayha to Sacramento river in Shasta county, Glenwood to Santa Cruz in Santa Cruz county, and two stretches in Los Angeles county, a total of over 140 miles. In addition, the road from Glenwood to Alma in Santa Cruz and Santa Clara counties is practically completed, the road from Williams to Arbuckle in Colusa county is ready for traffic and the Yolo causeway, which will reduce the distance between Sacramento and San Francisco about 50 miles is nearly completed. The new piers at Long Beach are over half completed. The first section of the California Southern railroad, projected to run from Blythe Junction to Blythe in the Palo Verde valley, about 40 miles, has been completed as far as Gyp Wells, a distance of 12 miles.

General Summary

Condensed From Our Daily Construction News Service.

CALIFORNIA

ALHAMBRA—Cities of Alhambra, Pasadena, and South Pasadena have decided to combine on the matter of sewage disposal. A board composed of the city engineers of the three cities, R. V. Orbison, Pasadena, John MacMillan, South Pasadena, and C. E. Hewes, Alhambra, has been appointed to study the problem and to report on a general plan.

AUBURN—Election has been called for November 16 to vote on bond issue to provide funds for construction of septic tank, extension of sewer-system, purchase of three fire-trucks, and installation of fire-alarm system.

BAKERSFIELD—Contract for construction of section No. 4 of road to Glennville has been awarded to Shattuck-Nimmo Warehouse Co.——Contract for construction of bridges and culverts on road to McKittrick has been awarded to M. T. Kean for $12,350.78.——Contract for construction of concrete highway on Weed Patch loop has been awarded to Worswick Street Paving Co., Fresno, for $31,460.40.——Contract for construction of section No. 1 of road to McKittrick has been awarded to Shattuck-Nimmo Warehouse Co., for $28,802.95.——Shattuck-Nimmo Warehouse Co. was low bidder at $28,802 for construction of section No. 5 of McKittrick road.

CHICO—Southern Pacific Co. will take over management of Butte County railroad when lease of Diamond Match Co. expires December 1, and may extend road from Stirling City to Westwood.

EAST SAN DIEGO—Contract for improving Hugo avenue has been awarded to M. D. Goodbody, San Diego, at 42c. per cu. yd. for excavation, $1.35 per cu. yd. for decomposed granite, 11¾c. per sq. ft. for sidewalks, 37c. per lin. ft. for curbs, 8c. per sq. ft. for cobblestone gutters, 10c. per lin. ft. for curb-bar, a total of $39,607.02.

EMERYVILLE—Contract for paving Powell street has been awarded to Oakland Paving Co., First National Savings Bank Bdg., Oakland. Estimated cost is $14,000.

FRESNO—Board of directors of Burnett sanitarium are considering construction of concrete hospital building costing $80,000. D. H. Trowbridge is secretary, and Krafft & Sons, Phelan Bdg., San Francisco, are architects.——City engineer B. E. Cronkhite is preparing plans for storm and sanitary sewers. Estimated cost is $150,000. Plans will be completed about January 1.

GLENDALE—Contract for improving Second street has been awarded to E. Schelling, Burbank, at 18c. per lin. ft. for grading, 4½c. per sq. ft. for oil macadam pavement, 26c. per lin. ft. for curbs, and 9c. per sq. ft. for sidewalks.

HANFORD—Contract for construction of concrete bridge over Lakeside canal on State highway has been awarded to H. E. Walker, Los Angeles, for $8.50 per cu. yd. or $2042 in all.——Contract for construction of highway No. 1, Division No. 1, Section No. 1, and Divison No. 2 has been awarded to Thompson Bros., Fresno, at the following unit prices: 14,076 cu. yd. excavation at 35c.; 22,950 tons asphaltic macadam in place at $1.37, 400 lin. ft. guard-fence at 60c.——Standard Corrugated Pipe Co., Rialto Bdg., San Francisco, has been awarded contract for furnishing corrugated culverts to county highway commission at the following prices per lin. ft. f.o.b. Hanford: 12-in., $0.75; 18-in., $1.07; 24-in., $1.41; 30-in., $2.04. Prices f.o.b. factory were $0.695, $1.00, $1.31, and $1.89, respectively. Contract for furnishing reinforcing steel has been awarded to Pacific Coast Steel Co., Rialto Bdg., San Francisco, at the following prices per 100 lb., f.o.b. Hanford; ¾-in. bars, $2.15; ⅝-in., $2.20; ½-in., $2.25; ⅜-in., $2.40. Prices f.o.b. factory were $1.80, $1.85, $1.90, and $2.05, respectively.——Contract for furnishing cement was divided between Lucerne Lumber Co., representing Santa Cruz Portland Cement Co., and Standard Portland Cement Corp., and the Ross Lumber Co., representing Pacific Portland Cement Co. at $15 per ton f.o.b. Hanford.——Contract for construction of bridges and culverts on road from Hanford to Lemoore has been awarded to Mercereau Bridge & Construction Co., Pacific Electric Bdg., Los Angeles, at $5.69 per cu. yd. for class A concrete, $5.98 per cu. yd. for class B, 1½c. per lb. for reinforcing steel, 30c. per lin. ft. for 12-in. corrugated pipe, 40c. for 18-in., 55c. for 24-in., and 75c. for 30-in. County furnishes cement,

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sand, rock, steel, and pipe at nearest siding.——Contract for the construction of concrete bridges and culverts on the Kings County highway from Hanford to Guernsey has been awarded to Frank Gallagher, Hanford. The unit prices bid are $7.83 per cu. yd. for class A concrete; $7.50 per cu. yd. for class B concrete; 1¾c. per lb. for cutting, hauling, and installing steel; 29½c. per foot for 12-in. corrugated pipe; 36c. for 18-in. and 42c. for 24-in. corrugated pipe. S. G. Smart and the Mercereau Bridge Co. also bid on this work.

HILLSBOROUGH—Street committee has recommended acceptance of bid of Raisch Improvement Co., Crocker Bdg., San Francisco, for street improvements as follows: 3300 cu. yd. excavation at $0.45, 200 cu. yd. concrete in culverts at $12, 125 lb. reinforcement at $0.10, 142,400 sq. ft. 1½-in. asphalt wearing surface on 4-in. concrete base at $0.114, 17,600 sq. ft. 2-in. asphalt wearing surface at $0.06, 100 tons of crushed rock at $3.25, corrugated culverts at $110.20, a total of $21,631.30.

HOLLISTER—Contract for grading and graveling four miles of Tres Pinos-Paicines road has been awarded to John McReynolds, San Jose, for $7941.07.

LONG BEACH—Contract for improving 6th street has been awarded to Fairchild-Gilmore-Wilton Co., Pacific Electric Bdg., Los Angeles, at 18c. per sq. ft. for paving, 28c. per lin. ft. for cement curb, and 20c. per sq. ft. for cement gutters.——Charles Voorheis, 188 Montague street, New York, is preparing plans for bulkhead and walk along west beach.

LOS ANGELES—Contract for improvement of De Longpre avenue has been awarded to E. Schelling, Burbank, at 1c. per sq. ft. for grading, 2¼c. per sq. ft. for cultivating, tamping, and oiling, 30c. per lin. ft. for curbs, 10c. per sq. ft. for sidewalks, 15c. per sq. ft. for concrete gutter, a total of $2486.92.——Contract for improving Baxter street has been awarded to Coast Construction Co., 353 South Hill street, at 4c. per sq. ft. for grading, 12½c. per sq. ft. for concrete paving, 30c. per lin. ft. for curbs, 10c. per sq. ft. for sidewalks, a total of $4002.98.——Contract for improving Kingsley drive has been awarded to George H. Oswald, 405 O. T. Johnson Bdg., at 1c. per sq. ft for grading, 11½c. per sq. ft. for asphalt pavement, 30c. per lin. ft. for cement curb, 10c. per sq. ft. for sidewalks, and 40c. per sq. ft. for granite-block gutter, a total of $4916.51.——Contract for improving Fairman street has been awarded to Wattson & Spicer, 310 Wright & Callender Bdg., at 4½c. per sq. ft. for grading, 2c. per sq. ft. for cultivating, tamping, and oiling, 30c. per lin. ft. for cement curb, 10c. per sq. ft. for cement sidewalk, and 15c. per sq. ft. for concrete gutter, a total of $3589.61.——Contract for improving La Salle avenue has been awarded to G. T. McLain, 4834 Fountain avenue, at ½c. per sq. ft. for grading, 2c. per sq. ft. for cultivating, tamping, and oiling, and 14½c. per sq. ft. for concrete gutters, a total of $549.34.——Contract for improving Madison avenue has been awarded to Wattson & Spicer, at 1½c. per sq. ft. for grading, 2c. per sq. ft. for cultivating, tamping, and oiling, 30c. per lin. ft. for concrete curbs, 11c. per sq. ft. for sidewalks, and 15c. per sq. ft. for concrete gutters, a total of $8413.78.——Ford & Stout, Bradbury Bdg., have been awarded contract for improving 7th street at 1c. per sq. ft. for grading, 11½c. per sq. ft. for asphalt pavement, 6c. per sq. ft. for asphalt wearing surface, and 40c. per sq. ft. for granite-block gutter.——Contract for improvement of North Boyle avenue has been awarded to William Liddington, 420 East 60th street, at 30c. per lin. ft. for concrete curbs, and 10c. per sq. ft. for sidewalks, a total of $910.50.——Adam Dalmatin, 475 South Savannah street, has been awarded contract for construction of sewer on Myra avenue at $27,945.——California-Arizona Construction Co., 1700 East Washington street, has been awarded contract for improvement of alley near 23rd street at 2.7c. per sq. ft. for grading, 10.9c. per sq. ft. for asphaltic concrete paving, 15c. per sq. ft. for concrete gutter, and 40c. per sq. ft. for granite-block gutter, a total of $1304.40.——California-Arizona Construction Co. has been awarded contract for improving Rampart boulevard at 1c. per sq. ft. for grading, 10.9c. per sq. ft. for asphalt pavement on 4-in. base, 11.6c. per sq. ft. for 5-in., and 12.6c. per sq. ft. for 6-in. base; 30c. per lin. ft. for concrete curb, 15c. per sq. ft. for concrete gutter, 4.3c. per sq. ft. for binder and asphalt surface, a total of $32,297.72.——Fairchild-Gilmore-Wilton Co., Pacific Electric Bdg., has been awarded contract for improving 38th street in San Pedro at 3c. per sq. ft. for grading, 15.7c. per sq. ft. for warrenite paving, and 35c. per lin. ft. for concrete curbs, a total of $8570.82. California-Arizona Construction Co. bid $8972.16.——Contract for paving 22nd street from Hoover street to Vermont avenue, has been awarded to George Oswald for the following prices: 10½c. per sq. ft. for asphalt paving; 1c. per sq. ft. for grading to sub-grade, 27c. per lin. ft. for cement curb; 35c. per sq. ft. for granite block gutter; 9c. per sq. ft. for cement sidewalk.——Contract for improving La Salle avenue has been awarded to G. T. McLain, 4834 Fountain avenue, at ½c. per sq. ft. for grading, 2c. per sq. ft. for cultivating, tamping, and oiling, and 14½c. per sq. ft. for concrete gutters, a total of $549.34.——Contract for improving Madison avenue has been awarded to Wattson & Spicer, at 1½c. per sq. ft. for grading, 2c. per sq. ft. for cultivating, tamping, and oiling, 30c. per lin. ft. for concrete curbs, 11c. per sq. ft. for sidewalks, and 15c. per sq. ft. for concrete gutters, a total of $8413.78.——Ford & Stout, Bradbury Bdg., have been awarded contract for improving 7th street at 1c. per sq. ft. for grading, 11½c. per sq. ft. for asphalt pavement, 6c. per sq. ft. for asphalt wearing surface, and 40c. per sq. ft. for granite-block gutter.——American Trona Corporation, Trust & Savings Bdg., will construct potash and borax refinery at San Pedro.——Contract for improving 58th street has been awarded to California-Arizona Construction Co., at 1c. per sq. ft. for grading, 10c. per sq. ft. for asphalt paving, 30c. per lin. ft. for curbs, 10c. per sq. ft. for sidewalks, 12½c. per sq. ft. for concrete gutters, 40c. per sq. ft. for granite-block gutters, a total of $1949.95.

MADERA—Movement for organization of irrigation district is well under way. J. G. Roberts is chairman and W. S. Orvis is secretary of committee.

MANHATTAN BEACH—Contract for improving several alleys has been awarded to Modern Construction Co. at 18½c. per sq. ft. for concrete pavement, 19.7c. per sq. ft. for concrete pavement with oil and screening surface, 30c. per lin. ft. for curbs, total, $8247.

MEADOW VALLEY—Spanish Peak Lumber Co. will construct lumber tramway. United States Steel Products Co. will furnish material for $35,536.

MODESTO—Bids will be received by the Board of Directors of the Modesto Irrigation District until November 6 for the following work: 1. Construction of nine reinforced concrete structures, Lateral No.3, Modesto Irrigation District. 2. Construction of a plain and reinforced concrete transition outlet structure to the permanent flume over Dry creek.——Contract for the construction of four concrete bridges was awarded to F. F. Reames and R. M. Simpson for $4538.——The Board of Supervisors of Stanislaus county has appropriated $85,000 for the construction of a concrete bridge over Tuolumne river.——Board of Directors of Modesto irrigation district has awarded the following contracts: Construction of reinforced concrete curtain-wall and protecting face on dam No. 6 of Dallas reservoir to Tibbetts-Pacific Co., San Francisco, for $9080; construction of reinforced concrete curtain-wall and protecting face on dam No. 1 of Dallas reservoir to John Monk, Sharon Bdg., San Francisco, for $57,971; construction of 11 reinforced concrete structures on lateral No. 6 between main canal and lateral No. 7 to Chris Holm, Riverbank, for $14,953.75; construction of concrete lining in section of main canal between Morton and Salter fills, to James Willison, San Mateo, for $14,953.75. F. C. Herrmann, Merchants Exchange Bdg., San Francisco, is chief engineer.

OAKDALE—Directors of South San Joaquin irrigation district will construct small reservoir near Eugene.

OAKLAND—Contract for improvement of 25th avenue has been awarded to Hutchinson Co., 13th and Franklin streets, at 35c. per cu. yd. for excavation, 10c. per lin. ft. for redwood curbs, 13c. per sq. ft. for concrete gutter, 9c. per sq. ft. for oil macadam pavement, 10c. per sq. ft. for cement sidewalks, 70c. per lin. ft. for 8-in. sewer, and $30 each for storm-water inlets.——Contract for construction of Mission Hill road has been awarded to Hutchinson Co., 13th and Franklin streets.

ONTARIO—Contract for improving Euclid avenue has been awarded to Ford & Stout, Bradbury Bdg., Los Angeles, at 9¼c. per sq. ft. for 4-in. concrete pavement, 8½c. per sq. ft. for 4-in. macadam, and 11c. per sq. ft. for 5-in. concrete gutters. B. B. Mann is city engineer.

OROVILLE—Landowners of Thermalito district are considering two proposals for an irrigation district; one for a district containing 2000 acres and purchasing water from Oro Electric Corporation, and the other for a larger district taking water from west branch of Feather river. E. C. Wilson, Pentz, is interested in the second scheme.

PASADENA—Contract for construction of 3206 lin. ft. of open drain with reinforced concrete sides and cobble-stone bottom has been awarded to J. E. Haddock, North Chester avenue, for $25,900.

PATTERSON—Surveys are being made for Patterson & Western railroad, from Patterson to magnesite mines, a distance of 22 miles. C. S. Compton, 841 56th street, Oakland, is chief engineer. Road will be narrow-gauge.

PORTERSVILLE—Southern Pacific Co. has completed surveys for branch line from point north of town to mines of Porterville Magnesite Company.——Contract for paving several streets has been awarded to Federal Construction Co., Sharon Bdg., San Francisco, at 12.83c. per sq. ft. for 1½-in. topeka specification pavement on 5-in. concrete base.

REDDING—Engineers' report on Pit River irrigation project estimates total cost at $6,050,000 and irrigable land at 55,000 acres.

REDONDO BEACH—Contract for construction of municipal pier, which had been awarded to Leyden-Ortseifen Co., of Chicago, has been assigned to McArthur Bros. Co. of New York.

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RIVERSIDE—Contract for improving 9.29 miles of route No. 11 has been awarded to C. L. Hyde Construction Co., 333 Spreckles Bdg., San Diego, at 37c. per cu. yd. for excavation, 8c. per lin. ft. shaping roadbed, $15 per cu. yd. for concrete in structures, $2.40 per cu. yd. for concrete in pavement, 5c. per lb. for reinforcing steel, a total of $38,740.70.

SACRAMENTO—State Reclamation Board has reported against strengthening levees for reclamation districts No. 785 and 537 on the ground that it is too late in the season to commence work.——City Board of Education has recommended bond issue of $2,650,000 for purchase of school site and construction of school buildings.——The plans of R. A. Herold for the new County Hospital have been adopted by the Board of Supervisors. Estimated cost is $400,000.——George W. Peltier will construct brick building on Ninth and K streets. Estimated cost is $25,000. ——Contract has been awarded by the Board of Supervisors to Clark & Henery for the construction of three miles of concrete road connecting Hood and Franklin. Total bid was $26,000.——The following bids have been received for State highway work: Mariposa county, Division 4, Route 18, Section A: Geo. R. Daley, San Diego, $42,748.60; Toohey & Johnson, Dunsmuir, $45,285.30; G. W. Conners, Eureka, $46,860.20; W. J. Schmidt, Berkeley, $47,522.50; F. Rolandi, San Francisco, $49,254.80; J. F. Fitzpatrick, Red Bluff, $50,557.40; Occidental Construction Co., Los Angeles, $58,900.90; Geo. S. Benson & Sons, Los Angeles, $59,-160.20. The following unit prices were submitted by George R. Daley: Excavation, ordinary, 38c.; excavation, solid rock, $1.50; 12-in. corrugated pipe, 80c.; 18-in. corrugated pipe, 90c.; 24-in. corrugated pipe, $1.00; 30-in. corrugated pipe, $1.25; Class B concrete, $20; guard rail, 75c. Placer county, Division 3, Route 3, Section B: C. H. and A. W. Gorrill, San Francisco, $47,339.80; Twohy Bros. Co., San Francisco, $49,113.60; Whitlock & Gorrill, Durham, $50,582; Taylor & Bechner, Willows, $53,002.50; M. Blumenkranz, Stockton, $54,308; L. F. Gerdetz Co., San Francisco, $56,368; Manuel Jacinto, Sacramento, $56,586; Forest City Paving & Construction Co., Live Oak, $56,809.80; Palmer & McBryde, San Francisco, $59,953.50; G. W. Conners, Eureka, $63,-161.50; Bates, Borland & Ayer, Oakland, $63,935. Following unit prices were submitted by C. H. & A. W. Gorrill: Excavation without classification, 39c.; 12-in. corrugated pipe, 55c.; 18-in. corrugated pipe, 60c.; 24-in. corrugated pipe, 70c.; class B concrete, culverts, and monuments, $9; class B concrete, pavement, $2.98; guard rail, 30c. Sonoma county, Division 4, Route 8, Section A: Bates, Borland & Ayer, Oakland, $22,182.90; Spring Construction Co., Berkeley, $22,852.18; P. H. Hoare, Oakland, $24,869.20; Moffett & Mead, San Francisco, $25,408.60; J. A. Marshall, Berkeley, $26,242.20; Palmer & McBryde, San Francisco, $27,176; A. J. Fairbanks, Willits, $27,650.20; Bauer & Beard, Two Rivers, $27,726.40; O'Brien Bros., Martinez, $28,-205.10; G. W. Conners, Eureka, $29,162.70; W. B. Hunt & Sons, Alameda, $30,903.20; F. Rolandi, San Francisco, $35,845.40; L. F. Gerdetz Co., San Francisco, $36,021.80. The following unit prices were submitted by Bates, Boreland & Ayer: Excavation without classification, 38c.; Oregon Pine lumber in place, $32; redwood lumber in place, $40; 12-in. corrugated pipe, 50c.; 15-in. corrugated pipe, 55c.; 18-in. corrugated pipe, 60c.; 24-in. corrugated pipe, 65c.; 30-in. corrugated pipe, 75c.; 4-in. tile drain, 35c.; class B concrete, $10; moving and resetting property fences, 5c.; new property fences, board and wire, 4c.; new property fences, woven wire, 4½c.——Sacramento West Side levee district is preparing plans for reclamation work costing $500,000. Haviland & Tibbetts, Alaska Commercial Bdg., San Francisco, are engineers.

SALINAS—Contract for bank-protection work at King City has been awarded to Lou G. Hare for $19,800.——Contract for grading and macadamizing part of Salinas-Watsonville road has been awarded to Granite Rock Company.

SAN DIEGO—City engineer George Cromwell has reported in favor of construction of Barrett dam as against Pine Creek dam. Estimated cost of Barrett dam is $155,000 and of Pine Creek dam is $177,000.

SAN FERNANDO.—Court decision has been rendered validating bond issue of $2,600,000 for irrigation system. Water is to be taken from Los Angeles aqueduct and conveyed in pipes to each 40-acre tract in entire district comprising 70,000 acres.

SAN JOSE—Contract for construction of 24,570 lin. ft. of concrete base pavement 18 ft. wide on Stevens Creek road and Saratoga avenue has been awarded to John McDonald, Jr., for $49,497.——Contract for improvements at Allen school has been awarded to M. Montoya at 8c. per sq. ft. for sidewalks and 40c. per lin. ft. for curbs and gutters.

SAN MATEO—Bids will be received early in November for construction of pavement, curbs, gutters, catch-basins, sewers, and culverts on several streets. W. C. Hammatt, 202 Hearst Bdg., San Francisco, is city engineer.

SAN RAFAEL—Contract for construction of roads from Bloom ranch to Two Rock and from Lagunitas to Tocaloma has been awarded to S. P. Brownless for $4606. Contract for construction of storm sewer along Pastori road has been awarded to W. J. Tobin Co., 735 Filbert street, Oakland, for $1161.——City council has adopted plans for extensive street-paving. F. J. Boland is city manager.

SAN FRANCISCO—Railroad Commission has ordered Atchison, Topeka & Santa Fe railroad to construct line from Oceanside to Temecula, 25 miles. Estimated cost is $700,000 to $800,000. Company will probably appeal case.——Board of Public Works will receive bids until November 24 for construction of 67-mile railroad from Rosasco to Hetch-Hetchy valley.——The following bids have been received by the Board of Public Works for the construction of the Ocean Beach Esplanade. (A) Price per lineal foot for construction of reinforced concrete esplanade, Section A. Estimate, 600 lineal feet. (B) Price per cubic yard for reconstruction of rubble wall. Estimate, 300 cubic yards.

	A	B
C. E. Lamburth	$ 74.00	$ 6.00
Western Building & Engineering Co	75.34	3.33
Foster & Vogt	93.33	4.95
Clinton Construction Co	97.00	1.00
John Grace	97.70	8.00
E. S. Mulford	98.00	6.00
L. F. Gerdetz & Co	105.00	7.50
F. Rolandi	106.00	4.50
Healy-Tibbitts Construction Co	109.00	5.00
Lange & Bergstrom	124.00	11.60
Tibbitts Pacific Co	165.50	8.00

Contract for improving Rhode Island street has been awarded to Flinn & Treacy, First National Bank Bdg., for $17,557.——Contract for improving Elsie street has been awarded to Eaton & Smith, 11th and Harrison streets, for $2270.——Contract for improving Harkness street and Wilde street has been awarded to M. Murphy for $5311.——Contract for improving Excelsior street has been awarded to F. R. Ritchie & Co., Chronicle Bdg., for $3292.——Contract for improving San Bruno avenue has been awarded to City Street Improvement Co., 166 Geary street, for $2500.

SANTA ANA—Contract for construction of 4450 lin. ft. of 4-in. asphaltic concrete pavement on Garden Grove road has been awarded to O. & C. Construction Co., Fullerton, for $9497.50.——L. L. Shaw, Santa Ana, J. A. Armitage, Sunset Beach, and others have been appointed on committee to investigate possibility of developing harbor at Newport bay.——Bonds for $25,000 have been voted in Westminster drainage district for construction of drainage system emptying into Alamitos bay.

SANTA BARBARA—Contract for improving Micheltorena street has been awarded to F. R. Ritchie & Co., Chronicle Bdg., San Francisco, at 19¾c. per sq. ft. for 4-in. concrete base and 2-in. asphaltic wearing surface, 20c. per sq. ft. for concrete gutter, $1.10 per lin. ft. for combined curb and gutter, 75c. per lin. ft. for stone curbs, a total of $8345.

SANTA CRUZ—The following bids were received for the construction of the Santa Cruz-San Benito counties' bridge at Chittenden: U. S. Steel Products Co., $4017, for the steel f.o.b. cars at Chittenden; J. G. Williams Construction Co., $1900, for the construction of the superstructure. No other bids were received.

SANGER—Contract for macadamizing three miles of street has been awarded to M. Haynes, Oakland, for $23,801.80.

STOCKTON—Contract for construction of concrete curbs, gutters, and sidewalks, and asphaltic concrete pavement on East street has been awarded to Clark & Henery Construction Co. for $4510.20. Engineer's estimate was $5512.60.——Contract for construction of $20,000 building for R. E. Wilhoit has been awarded to Tom Lewis.——Contract for construction of storm-sewers in Fair Oaks district has been awarded to Tibbetts-Pacific Co., San Francisco, for $14,330.49. Engineer's estimate was $17,678.30.——Contract for paving water-front space on south side of Stockton channel has been awarded to Federal Construction Co., Sharon Bdg., San Francisco, for $2058.22. Engineer's estimate was $2290.45.——Contract for grading and graveling about two miles of George M. Pocock road has been awarded to G. Gilgert for $3289.20.

TRACY—West Side irrigation district, comprising 11,500 acres of land near Tracy and Bethany, was ratified at election. George Parker has been elected assessor and Cornelius Looney, tax-collector. No engineer has been appointed as yet and no definite plans made, but it is expected to obtain water by pumping from Old river and that the cost of the work will be $285,000.

TURLOCK—Improvements costing $200,000 to system of Turlock irrigation district are now under way. Work is being done by day-labor under the direction of R. V. Meikle, engineer for the district.

VACAVILLE—Following bids have been received by city trustees for completion of State highway through city: Bentley & Gates, $10,854.95, awarded contract; Wrightson & Jost, $11,152.50; Blumenkranz & Co., $11,465; and Paige & Co., $16,500.

VENICE—Contract for grading and paving Venice boulevard

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has been awarded to J. D. Kneen Contracting Co., Santa Monica, for $22.4c. per square foot.

VENTURA—Contract for paving extension to Bardsdale bridge has been awarded to Conrad Sherer, 511 Stimson Bdg., Los Angeles, for about 8c. per sq. ft. for 3-in. bituminous macadam pavement.

VISALIA—Contract for construction of Three Rivers road has been awarded to J. E. Hines, Tulare, for $13,800.

WILLOWS—John P. Ryan has been retained as engineer to report on proposed outside sewer-district. Estimated cost of work is $20,000.——Contract for construction of drainage ditch on Galland & Lowenstine ranch, involving 20,300 cu. yd. excavation has been awarded to E. H. Cameron for 15c. per cubic yard.

WOODLAND—Board of supervisors has decided to construct $200,000 court-house as soon as finances can be arranged. W. H. Weeks, 75 Post street, San Francisco, is architect.

YUBA CITY—Plans are being prepared for the construction of a steel draw-bridge over Feather river at Nicholaus. Estimated cost is $75,000.

IDAHO

ALBION—Bonds for $8000 for construction of lighting system have been voted.

BLACKFOOT—Construction of lighting system to be operated by Diesel engine is proposed. Estimated cost is $2300. F. W. Riley, Idaho Falls, is engineer.

BOISE—Contract for construction of state highway in Bannock county has been awarded to Reese & Munson, Pocatello. ——Contract for construction of reinforced concrete bridges in Bannock county has been awarded to Long & Blodgett, Gooding. ——Contract for construction of steel bridges in Power county has been awarded to Charles H. Mull, Twin Falls.——Bids will be received at Supervising Architect's Office, Treasury Department, Washington, D. C., until 3 p.m., November 18, for extension and remodeling of post-office.

KELLOGG—City clerk is receiving bids for construction of sewers in Pressley addition. Estimated cost is $7000.

MOSCOW—Contract for construction of 1½-in. bituminous pavement on 5-in. concrete base has been awarded to Wyckoff & Green, Spokane, Washington, for $1.38 per sq. yd., or $13,000 in all.

MOUNTAIN HOME—Contract for extensions and improvements to system of Mountain Home Co-operative Irrigation Co. has been awarded to Many Bros., Boise.

POCATELLO—E. S. Anderson is preparing plans for construction of water-system. Estimated cost is $400,000.——The work of completing the survey of the State highway at Ashton has been completed and bids will soon be called for this work.

TWIN FALLS—The city of Twin Falls has agreed to purchase the Twin Falls Water Works system for $80,000.

MONTANA

BILLINGS—Contract for construction of two bridges in Big Horn county has been awarded to Security Bridge Co. for $35,072 in all.

BOZEMAN—Following bids have been received for re-surfacing Main street. Warren Construction Co., Portland, bitulithic, $1.21 per sq. yd.; sheet asphalt, $1.46 per sq. yd.; asphaltic concrete, $1.16 per sq. yd. Independent Asphalt Paving Co., Seattle, sheet asphalt, 97c. per sq. yd.; asphaltic concrete, 97c. per square yard.

BUTTE—Contract for construction of ornamental lighting system has been awarded to D. J. Reardon for $31,755.

CHOTEAU—Contract for construction of sanitary sewers has been awarded to Two Miracle Concrete Co., Kalispell, for $10,824.40.

FORT SHAW—Contract for concrete work on project of U. S. Reclamation Service has been awarded to Hans Pedersen, Madison block, Seattle, for $70,000.——Following contracts for work on project have been awarded by U. S. Reclamation Service: earthwork to J. E. Hilton, Billings; structures to West Coast Construction Co. and to Hans Pederssen, both of Seattle; wooden highway bridges to Threet Bros. & Jolley, Lovell, Wyoming.

FROMBERG—Contract for construction of water system has been awarded to Security Bridge Co., Billings, for $15,980

LEWISTON—Contract for construction of pavement in districts No. 22 and 23 has been awarded to J. C. McGuire.

OREGON

HEPPNER—Contract for construction of reinforced concrete bridge over Willow creek has been awarded to C. G. Huber, Central Bdg., Seattle, for $2970.

HOOD RIVER—Plans are being prepared for construction of road to snow-line on Mt. Hood. County Commissioner Hannum is interested. Estimated cost is $3500.

MARSHFIELD—Election will be held in December to vote on bond issue of $35,000 for erection of city hall. A. B. Gidley is city engineer.——Petitions are to be presented to county commissioners, asking them to call election to vote on bond issue of $370,000 for construction of county highway system.

NEWPORT—Citizens have offered $100,000 bonus to Portland & West Coast Railroad & Navigation Co. for early construction of proposed line to Portland.

PENDLETON—Contract for construction of Carnegie library has been awarded to Olson & Johnson, Missoula, Montana, for $31,200.

PORTLAND—Suttle Lake irrigation district has voted bonds for $533,390 for construction of gravity irrigation system with storage reservoirs at Suttle and Blue lakes. O. Laurgaard, Railway Exchange Bdg., is chief engineer.——Oregon, California & Eastern Railroad has been organized to build 400 miles of line in central Oregon and northern California. Robert L. Strahon, Northwestern Bank Bdg., is president.——Plans for new civic auditorium will soon be completed by J. H. Friedlander, of New York.——Plans have been prepared for construction of lower end of Tanner Creek trunk-sewer. Estimated cost is $50,000. P. H. Dater is city engineer.

SALEM—State water board has granted water to Paisley project and construction will commence soon. Project will cost $400,000 and will include earth dam with concrete core-wall. O. Laurgaard, 410 Railway Exchange Bdg., Portland, is engineer.——The State Highway Department has prepared plans and specifications for a reinforced concrete bridge over the Willamette river from Salem in Marion county to West Salem in Polk county. Estimated cost $225,000.——The State Highway Commission has appropriated $90,000 to assist Wasco county in building the link in the Columbia highway from Hood river to Mosier, a distance of 8 miles.——Wasco county contemplates holding an election sometime in November to vote bonds to the amount of $260,000 for road work.

WASHINGTON

ABERDEEN—Bond issue of $400,000 for construction of water-system has been voted, also $25,000 for purchase of toll-bridge across Chehalis river.

BELLINGHAM—Contract for asphalt paving and construction of curbs and gutters on Madison and Walnut streets has been awarded to Washington Paving Co., Tacoma, for $1.15 per sq. yd., or a total of $16,515.50.

CENTRALIA—Contract for construction of retaining wall near Meskill has been awarded to Hendricks & Ward, for $995.

DUVAL—W. A. Kelly, drainage and irrigation engineer for U. S. Department of Agriculture, is makng surveys for the reclamation of 3500 acres in King and Snohomish counties.

ELLENSBURG—Contract for construction of road to Peshastin has been awarded to Quigg Construction Co. Wenatchee, for $5595.20.

EVERETT—R. E. Koon, assistant engineer to Burns & McDonnell, is making survey for pipe-line from Sultan river to Everett.——Petition will be presented to supervisors asking for election to vote on bond issue of $1,900,000 for construction of county highway system.

GRANT ORCHARDS—Irrigation district containing 6500 acres has been formed. Bond issue of $75,000 is proposed. A. H. Wilburn, C. F. Berlet, and H. Rosensweig are directors.

KELSO—Contract for construction of 17½ miles of dike in district No. 1 has been awarded to Collier & Stevenson for $99,000.

NORTH YAKIMA—Contract for graveling 18 miles of permanent highway No. 13-A has been awarded to A. H. Zane & Co., for $6739.——Contract for grading 5½ miles of Wenas road has been awarded to Thomas Dingle for $7824.——Contract for construction of drainage system in district No. 27 has been awarded to Dunn & Hogan, for $19,656.

OAKVILLE—Plans are being prepared for construction of 1½ miles of street pavement. T. J. Watkins is interested.

OKANOGAN—All bids for construction of Riverside bridge have been rejected and new bids will be called for. Bowerman & McCloy, Mutual Life Bdg., Seattle, are engineers.

OLYMPIA—State Highway Commission has appropriated $48,175 for clearing and grubbing right-of-way for road from Lake Quiniault northeasterly.——Contract for construction of building for State School for Girls at Grand Mound has been awarded to S. C. Erickson, 1250 South Ainsworth street, Tacoma, for $49,471.——Contract for construction of buildings for State School for Feeble Minded at Medical Lake has been awarded to Boyajohn-Arnold Co., Panama Bdg., Portland, Oregon, for $277,000.——Contract for the construction of buildings for State Hospital for Insane at Sedro-Wolley has been awarded to Warrack Construction Co. for $134,763.40.——Contract for construction of Inland Empire highway between Colfax and Rosalia has been awarded to W. G. Mulford, Spokane, for $21,120. Contract for the section between Waitsburg and Dayton has been awarded to the General Construction Co., Spokane, for $13,242.

PROSSER—Landowners in this vicinity have formed irrigation district. Estimated cost of work is $10,000,000. John Sumner, Patterson, Ira W. Carter, Prosser, and W. A. Keiser, Kiona,

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are directors.——Contract for grading permanent highway No. 5 has been awarded to A. H. Zane, Hanford, for $19,230.

ROSLYN—Contract for construction of sewers has been awarded to Rutquist & Gustafson for $1425.

SEATTLE—Plans have been adopted for grade separation at Argo railroad station. Estimated cost is $750,000, which will be divided between the five railroads and the city.——Contract for construction of pavement on 20th avenue and other streets has been awarded to N. Fiorito & Bros., 616 26th avenue, for $21,481.33.——H. M. Chittenden, 2010 North Broadway, has reported to Port Commission in favor of improvements costing $412,500, including tunnel, embankment, and small bridge.——Contract for construction of building for Masonic temple has been awarded to Hans Pederson, Madison block, for $130,000.

SPOKANE—The following bids were received by the Board of Supervisors for addition to the Monroe Street bridge:

	Plan A.	Plan B.
Beer Co., Portland	$15,555	$16,666
Bates & Rogers, Spokane	28,535	31,473
Huetter Construction Co., Spokane	25,605	28,274
A. C. Biegle & Co., Spokane	26,694	29,700

Contract has been awarded to the Beer Company. The following bids were received for the construction of the Howard Street bridge: Beer Co., Portland, $18,888; Weymouth Bridge Co., Seattle, $24,300; Illinois Steel Bridge Co., Seattle, $24,974. Contract has been awarded to the Beer Company.

TACOMA—Contract for construction of four steel buildings for Tacoma Smelting & Refining Co. has been awarded to Cornell Bros., Savage-Scofield Bdg., for $250,000.——Puyallup Dredging Co. has commenced work on channel for Puyallup river, involving the moving of 3,000,000 cu. yd. of material.——Contract for construction of hotel in Rainier Park, has been awarded to Cornell Bros., Savage-Scofield Bdg., for $75,000.

Engineering Societies and Conventions

Idaho Society of Engineers. Ira F. Schaffner, secretary, Boise.

Los Angeles Section of American Society of Mechanical Engineers. Ford W. Harris, secretary, 1029 Higgins building.

Los Angeles Section of American Institute of Electrical Engineers. Edward Woodbury, secretary, 255 East 3rd street.

Oregon Society of Engineers. Orrin E. Stanley, secretary, room 409, City Hall, Portland.

Portland Association of Members of American Society of Civil Engineers. Charles McGonigle, president, care Western Sheet Metal Works.

Portland Section, American Institute of Electrical Engineers. Paul Lebenbaum, secretary, 45 Union Depot.

San Francisco Association of Members of American Society of Civil Engineers. E. T. Thurston, Jr., secretary, Mechanics Institute building.

San Francisco Section of American Society of Mechanical Engineers. F. W. Gay, secretary, care J. G. White & Co., Alaska Commercial building.

San Francisco Section of American Institute of Electrical Engineers. A. G. Jones, secretary, 811 Rialto building.

Southern California Association of Members of American Society of Civil Engineers. W. K. Barnard, secretary, 701 Central building, Los Angeles.

Coming Conventions

National Municipal League. Annual meeting, Dayton, Ohio, November 17-19. C. R. Woodruff, secretary, North American building, Philadelphia, Pennsylvania.

American Society of Mechanical Engineers. Annual meeting, New York, December 7-10. Calvin S. Rice, secretary, 29 West 39th street, New York.

American Institute of Chemical Engineers. Winter meeting, Baltimore, Maryland, January 12-15, 1916. J. C. Olsen, secretary, Cooper Union, New York.

National Conference on Concrete Road Building. Chicago, Illinois, February 15-18. J. P. Beck, secretary, 208 South La Salle street, Chicago, Illinois.

Personal

S. G. Chamberlain, formerly city engineer of San Fernando, California, has resumed the duties of that position.

H. M. Chittenden, who has been a member of the Port of Seattle Commission since its organization, has resigned.

W. M. Rumsey, formerly city engineer of San Diego, has opened offices as a civil engineer in the Granger Bdg., San Diego.

A. Bosworth, who has been engineer for the California State Highway Commission, with headquarters at Fresno, has been appointed city manager of Tulare, California.

James Cole Roberts, of the United States Bureau of Mines, has been appointed to the Joseph Austin Holmes professorship of safety and efficiency engineering at the Colorado School of Mines.

The Seattle Association of Members of the American Society of Civil Engineers has suggested J. B. C. Lockwood, of Portland, Oregon, for member of the nominating committee of the national society.

R. J. Wigg, of the United States Bureau of Standards visited San Francisco during October to investigate the action of seawater on concrete, but was obliged to return to Washington on account of the illness of his wife's mother.

L. R. Ferguson and H. W. Latta of the American Association of Portland Cement Manufacturers have been in San Francisco making preparations for the opening of a Pacific Coast branch of this association. Mr. Latta will take charge of the new office.

The following officers were elected by the American Electric Railway Association at their meeting in San Francisco: C. L. Henry, Indianapolis, president; L. S. Storrs, New Haven, Timothy S. Williams, Brooklyn, John J. Stanley, Cleveland, and J. H. Pardee, Pottsville, Pennsylvania, vice-presidents.

P. H. Everett, chief engineer for the Kern County highway commission, since the commencement of its work has resigned. H. C. Foster, assistant engineer for the commission has been appointed to fill the position temporarily, but it has not yet been decided whether or not to make the appointment permanent.

The following officers were elected by the International Gas Congress at their meeting in San Francisco: William E. McKay, Boston, president; Herman Russell, Rochester, J. D. von Maur, St. Louis, A. H. Elliott, Flushing, C. O. Bond, Philadelphia, and J. P. Crowley, St. Paul, vice-presidents; and George G. Ramsdell, secretary and treasurer.

Commercial Paragraphs

The Bucyrus Co., of South Milwaukee, Wisconsin, has opened an office at 900 Hibernian Bdg., Los Angeles, in charge of G. H. Hutchinson.

The American Association of Portland Cement Manufacturers will establish a Pacific Coast branch office in San Francisco in charge of H. W. Latta.

The Burd High Compression Ring Co., of Rockford, Illinois, announces the appointment of Robert Allan as district branch manager for Northern California, with headquarters at 847 Phelan Bdg., San Francisco.

The T. L. Smith Co., of Milwaukee, has taken over the entire business of the Albrecht Excavator Co. and will now have exclusive charge of the manufacture and sale of the Albrecht Excavator and Loader.

A world's record for low temperature was made by the machine exhibited by the Larsen Ice Machine Co., at the Panama-Pacific Exposition. The ammonia used was furnished by the Pacific Ammonia & Chemical Co., of Seattle and San Francisco.

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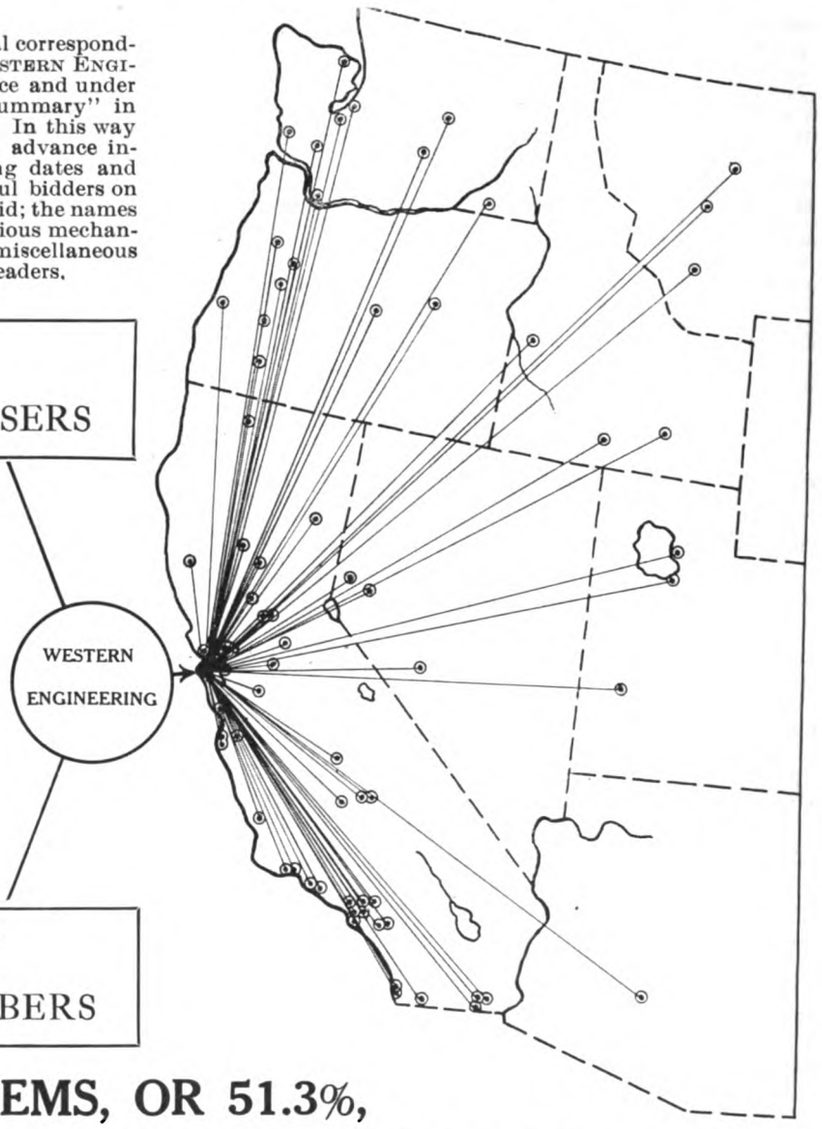

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Classified List of Items Published During September

Railways	18 items	Streets and Roads	184 items
Light, Heat, and Power	10 items	Sewers	41 items
Bridges	61 items	Buildings	35 items
Water Supply and Irrigation	52 items	U. S. Government Work	14 items
Miscellaneous items	55		

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